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Volume XII



PRODUCTION OF JET FUELS FROM COAL-DERIVED LIQUIDS

VOL XII--PRELIMINARY PROCESS DESIGN AND COST ESTIMATE AND PRODUCTION RUN
RECOMMENDATION

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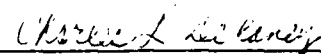
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SUMMARY

Amoco and Lummus Crest are contracted with the Department of Energy to develop an upgrading scheme for the liquid by-products (tar oil, phenols, and naphtha) produced by the Great Plains Coal Gasification plant in Beulah, North Dakota. These streams are currently burned in the utility boilers and steam superheaters in the Great Plains plant. Task 1 through 3 of the contract are complete. Task 1 results were reported previously (AFWAL-TR-87-2042, Volume VI), as were the results of Tasks 2 and 3 (AFWAL-TR-87-2042, Volume IX). The results of Tasks 4 and 5 are reported here.

A preliminary design for the production of JP-8 jet fuel and other salable products from the Great Plains by-products is given. The design incorporates experimental results from Tasks 2 and 3 with the scoping design from Task 1. The experimental results demonstrated the need for more severe hydrotreating conditions to convert the tar oil to jet fuel than were estimated in Task 1. As a result, capital costs for the revised design are significantly higher, and the plant is less profitable than estimated in the Task 1 work. The increase in capital costs is offset somewhat by a higher phenol value in the current market. In addition, the product slate has changed. BTX production, only marginally profitable in the Task 1 study, was re-evaluated and found to be prohibitive. As a consequence, the flow scheme is simplified by the removal of the aromatics recovery unit from the Task 1 design.

Recommendations are given for a 10,000-barrel production run. No commercial domestic facility exists which can provide suitable expanded-bed hydrotreating facilities for a production run of this size. However, an alternative approach using hot filtration and dilute fixed-bed hydrocracking followed by product fractionation and extensive hydrotreating of the heavy products is recommended. Commercial domestic facilities which might reasonably accommodate this scheme are listed.

FOREWORD

In September 1986, the Fuels Branch of the Aero Propulsion and Power Laboratory at Wright-Patterson Air Force Base, Ohio, commenced an investigation of the potential for production of jet fuel from the liquid by-product streams produced by the gasification of lignite at the Great Plains Gasification Plant located in Beulah, North Dakota. Funding was provided to the Department of Energy (DOE) Pittsburgh Energy Technology Center (PETC) to administer the experimental portion of this effort. This report details the effort of Amoco Oil Company, who, as a contractor to DOE (DOE Contract Number DE-AC22-87PC90015), conducted a preliminary analysis of upgrading alternatives for the production of turbine fuels from the Great Plains liquid by-product streams. DOE/PETC was funded through Military Interdepartmental Purchase Request (MIPR) FY1455-86-NO657. Mr. William E. Harrison III was the Air Force Program Manager, Mr. Gary Stiegel was the DOE/PETC Program Manager, and Mark Furlong and Bruce Fleming were the Amoco Program Managers.

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SECTION I
INTRODUCTION

The Great Plains Coal Gasification Plant in Beulah, North Dakota, produces about 145 MM SCF/D of substitute natural gas (SNG) from lignite. The plant also produces three liquid by-products: about 2,900 B/D of tar oil, 830 B/D of crude phenols, and 650 B/D of naphtha. These liquids are all products from the devolatilization of lignite in the Lurgi gasifiers. Currently, the by-products are burned in the plant's boilers and superheaters to produce steam. The economic viability of the plant might be improved by producing marketable products, rather than steam, from these by-product liquids. To this end, Amoco and Lummus Crest, under a contract with the United States Department of Energy, are investigating the technical and economic feasibility of converting the by-product liquids to jet fuels and other saleable products. Jet fuels are of particular interest because of the close proximity of Great Plains to several U.S. Air Force bases, and the obvious strategic interest in maintaining a constant, proprietary source of jet fuel for those bases.

SECTION II

PROJECT OVERVIEW

As shown in Figure 1, this project is divided into five major tasks: Process Concept Definition, Bench Scale Testing, Pilot Plant Testing, Preliminary Process Design and Economics, and Production Run Recommendation. The results of Tasks 4 and 5 are reported here.

The first task, Process Concept Definition, included three subtasks: Liquid By-product Analysis, Process Modelling and Design, and Economic Modelling. The first subtask (1.1), By-product Analysis, involved analytical characterizations of samples of each by-product taken at six-week intervals. The results from this program, which provided an indication of the average quality of each stream and the variability of that quality over time, were an important input to the second subtask (1.2), Process Modelling and Design. Other inputs to the second subtask included limited experimental processing data on the Great Plains by-products by the Western Research Institute (WRI),⁽¹⁾ Amoco's petroleum refining process models and linear programming technology, Lummus' process simulation and design programs and a market analysis of by-products from Great Plains developed by Sinor Consultants.⁽²⁾ In addition, throughout Task 1, ANG Coal Gasification Company provided valuable input and advice on all fronts. The major objective of Subtask 1.2 was to produce seven conceptual designs and associated capital and operating costs for facilities to refine the Great Plains by-products. These included designs for maximizing production of each grade of jet fuel (JP-4, JP-8, JP-8X), designs for profitable schemes which produce the various jet fuel grades, and a scheme for maximizing profits. In Subtask 1.3 the results generated by Amoco and Lummus were subjected to economic analysis.

The two products from Tasks 1 were the design and economic results for each of the seven designs and a plan for bench scale testing (Task 2) to confirm any assumptions made in Task 1. The final report for Task 1 was issued by the U.S. Air Force in September 1988.⁽³⁾ Based on the design and economic results from Task 1 and preliminary results from Task 2, the Department of Energy and the Department of Defense decided on a preferred processing scheme for the Great Plains liquids, the "Profitable JP-8" case developed in Task 1. Amoco carried out pilot plant testing (Task 3) of the process design from Tasks 1 and 2 and provided barrel quantities of product for testing by the United States Air Force and associated contractors. The final report for Tasks 2 and 3 was issued by the U.S. Air Force in June 1989.⁽⁴⁾

The pilot plant results were used by Amoco and Lummus to develop a preliminary process design and economics (Task 4) for a plant to upgrade the liquid by-products at Great Plains. Finally, in Task 5, Lummus suggested existing facilities where the processing scheme might be carried out on a scale sufficient to provide jet fuel for aircraft testing. The results of Tasks 4 and 5 are reported here.

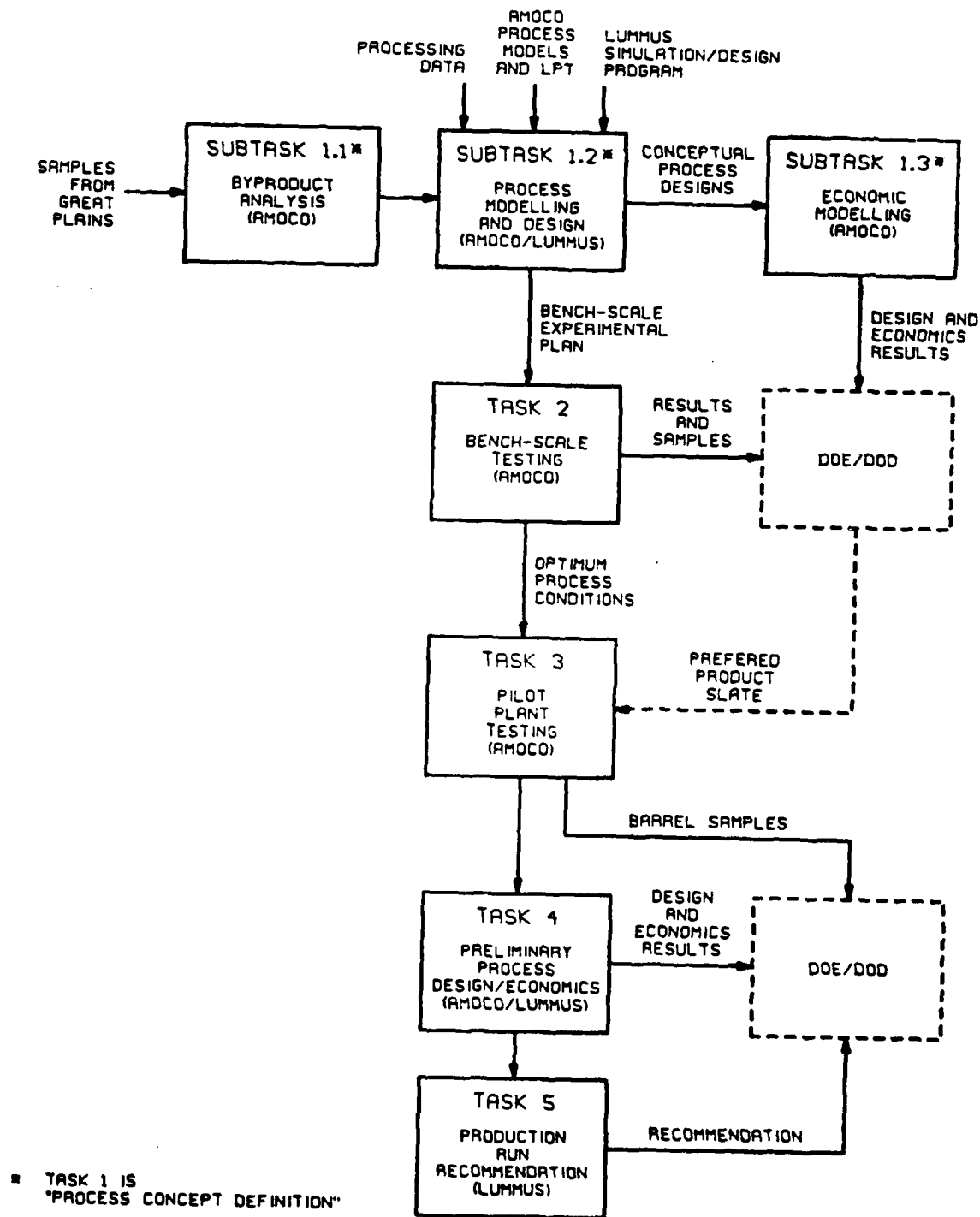


FIGURE 1
PRODUCTION OF JET FUEL
FROM COAL DERIVED LIQUIDS:
AMOCO/LUMMUS ACTIVITIES

SECTION III

SOURCE OF BY-PRODUCT LIQUIDS

Tar oils, crude phenols, and naphtha are produced at the Great Plains Gasification Plant; a schematic of the plant is shown in Figure 2. The plant currently produces about 145 MMSCFD of synthetic natural gas (SNG) from North Dakota lignite. The SNG is composed almost entirely of methane, which is derived mostly from synthesis gas ($H_2 + CO$) produced in the Lurgi Mark IV gasifiers and methanated in downstream reactors. The liquid by-products (tar oil, phenolics, and naphtha) are produced during lignite devolatilization in the gasifiers.

The tar oil and phenolics are condensed from the product gas along with water vapor to form a gas liquor. This condensation takes place in heat exchangers located in the gasifier quench, shift converter, gas cooling, and Rectisol units. The liquor is routed to the gas liquor separation unit, where the tar oil is recovered by gravity separation. The heaviest portion of the tar oil, which contains about 20 percent coal dust, is recycled to the gasifiers. The recycle rate of this "dusty tar" is about 1800 B/D. The remaining tar oil, which contains 2-6 percent dust, is produced at a rate of 2900 B/D. The phenolics are recovered from the gas liquor by extraction with isopropyl ether in the Phenolsolvan unit. The resulting crude phenol stream, which is produced at a rate of about 830 B/D, is composed mostly of phenol, cresol, and xylenol, with the remainder being water and neutral oils. The naphtha is condensed from the gasifier raw gas by contacting the stream with cold methanol in the Rectisol unit. The naphtha is produced at a rate of 650 B/D.

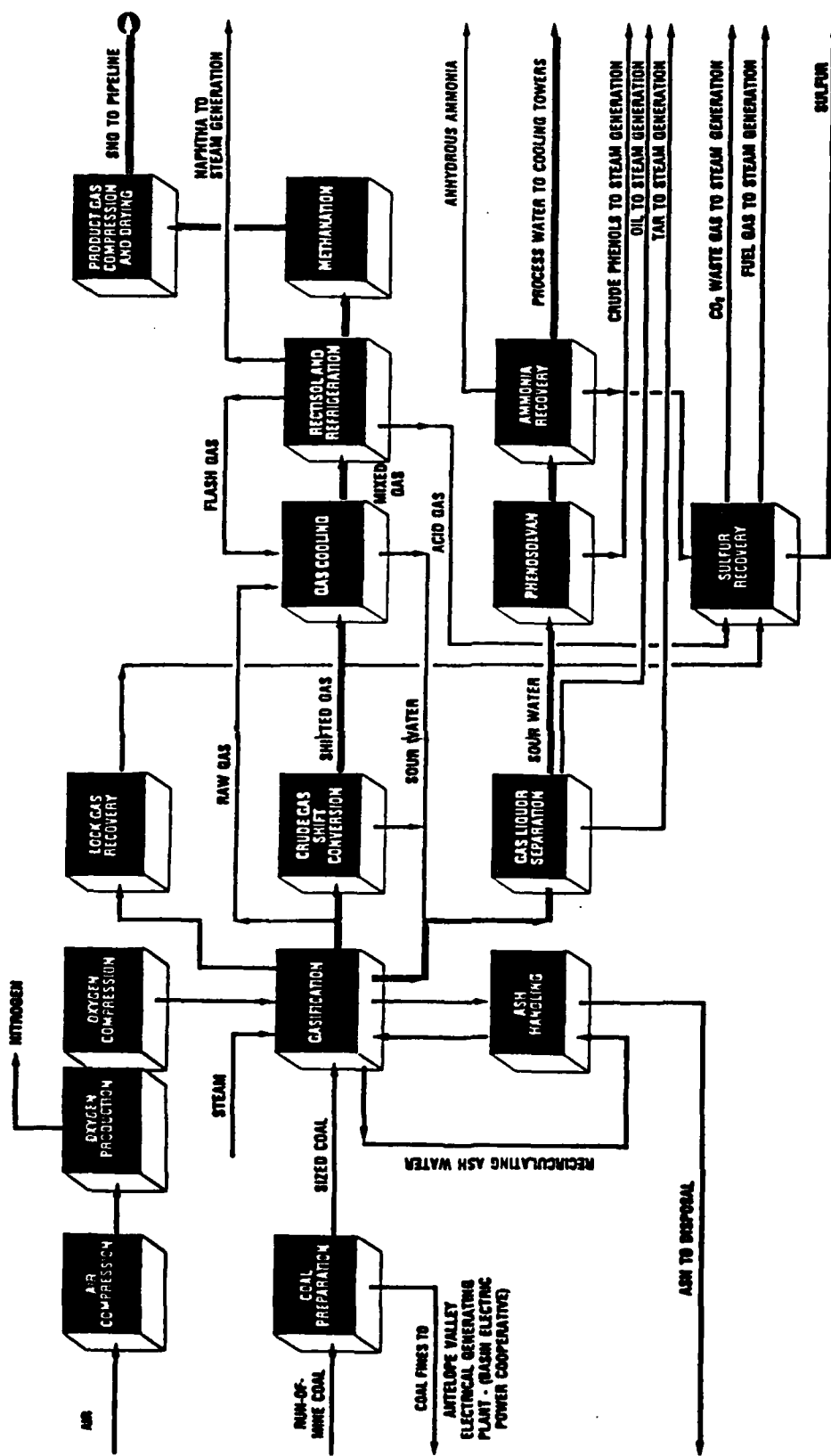


FIGURE 2. GREAT PLAINS GASIFICATION PROCESS BLOCK FLOW DIAGRAM

SECTION IV

TASK 4 RESULTS

1. Preliminary Process Design

Lummus Crest Inc., under subcontract with Amoco Oil on this project, generated a preliminary process design to convert the tar oil, naphtha, and phenols streams from the Great Plains Coal Gasification Plant to jet fuels, gasoline, and salable chemicals products. As part of Task 1 of this project, seven processing schemes were generated, as indicated in Table 1. Initial design bases were formulated for each case using proprietary linear programming techniques and process models from Amoco and design expertise at Lummus Crest Inc. The Task 1 results were reported earlier.⁽³⁾ As a part of Task 2 the U.S. Air Force and the Department of Energy selected Case 4, "Profitable Product Slate Including JP-8," as the case for further study in Tasks 3 through 5.

a. Overall Process Description

Figure 3 shows the block diagram for the preliminary process design. There are three sections to the design: tar oil processing section, naphtha processing, and phenol processing. Each is described briefly.

Tar Oil Processing--The tar oil stream is treated to make JP-8 jet fuel through an expanded-bed hydrotreater, a desulfurization/ denitrogenation unit (HDS), and a final stage of hydrocracking. Only the fraction of the tar oil boiling above 300°F is treated. The 300°F- fraction is removed by distillation prior to hydrotreating, as the low-boiling fraction is unsuitable for jet fuels.

The first stage hydrotreater consumes 3073 SCF hydrogen per barrel of feed, resulting in a high heat release and necessitating an expanded-bed reactor system to control the reactions. The design basis is a three-stage expanded-bed hydrotreater which removes over 98 percent of the sulfur, nitrogen, and oxygen and converts part of the 525°F+ material to the appropriate boiling range for jet fuel blending. From the hydrotreater, 3224 barrels per day of 200°F+ product is sent to the HDS unit and 162 barrels per day of naphtha is recovered.

The HDS unit desulfurizes and denitrogenates the 200°F+ product from the hydrotreater. Denitrogenation is required to preserve catalyst life in the hydrocracker unit and to produce a 525°F- stream suitable for jet fuel blending. The 525°F+ fraction is sent to the hydrocracker unit, a five-stage unit with 65% conversion per pass. The hydrocracker product is recycled to the HDS unit until the 525°F+ fraction is extinct.

Details of the tar oil processing scheme are given in Appendices A and B, and equipment data and estimate sheets are included in Appendix F.

TABLE 1

PROCESS MODEL AND DESIGN CASE SUMMARY

THE FOLLOWING DESIGN CASES WILL RESULT FROM ACTIVITIES IN THIS SUBTASK:

<u>CASE</u>	<u>DESCRIPTION</u>
1	MAXIMUM JP-4 PRODUCTION.
2	PROFITABLE PRODUCT SLATE INCLUDING JP-4.
3	MAXIMUM JP-8 PRODUCTION.
4	PROFITABLE PRODUCT SLATE INCLUDING JP-8.
5	MAXIMUM JP-8X PRODUCTION.
6	PROFITABLE PRODUCT SLATE INCLUDING JP-8X.
7	MAXIMUM PROFIT.

NOTE: CASES 2, 4, 6, AND 7 REQUIRE LINEAR PROGRAMMING TECHNOLOGY.

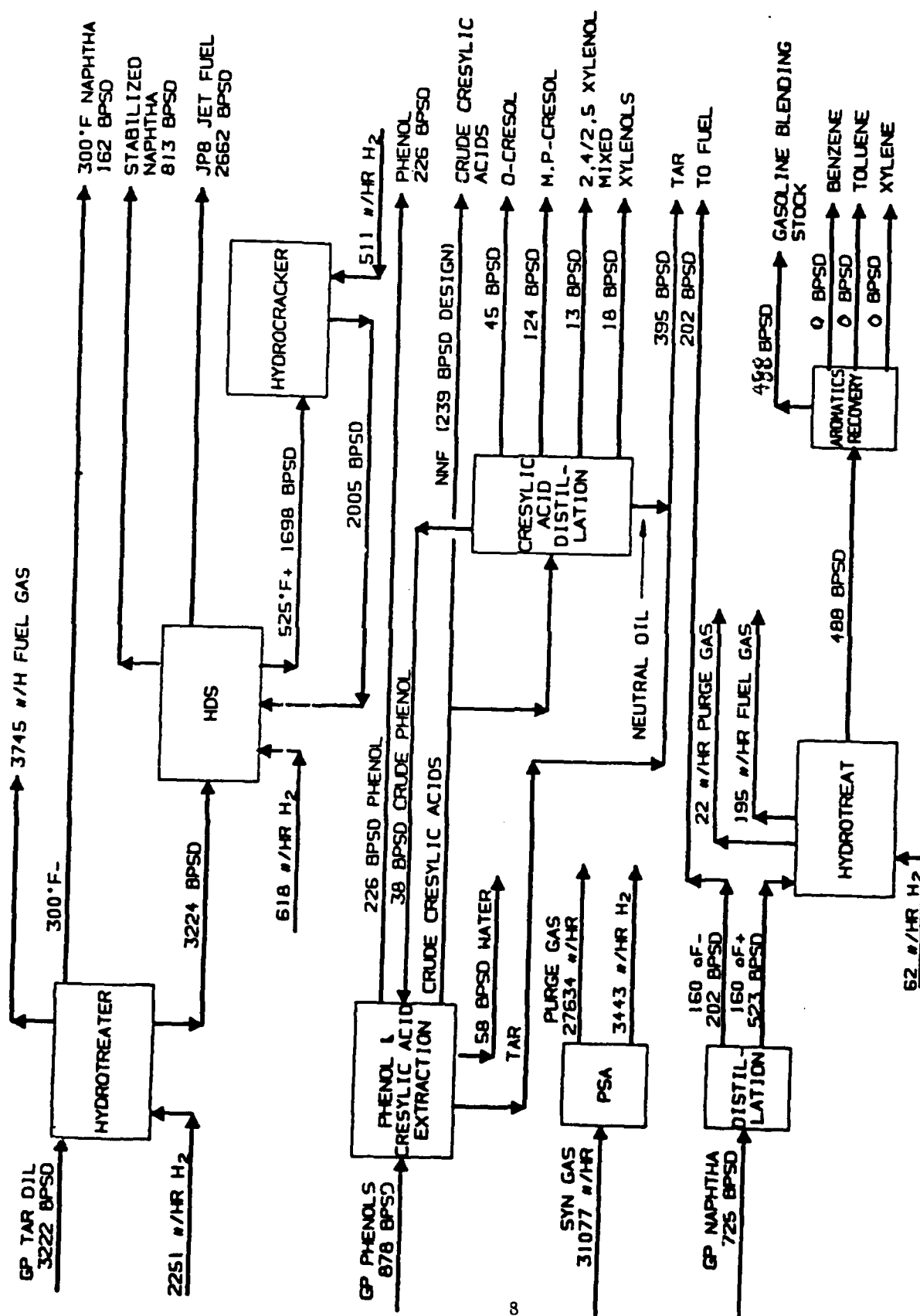


FIGURE 3: PROFITABLE JP-8 DESIGN

Naphtha Processing--Figure 3 shows a naphtha processing scheme that could produce BTX from the 725 barrels per day of raw Great Plains naphtha. The Task 1 study reported this treatment scheme as only marginally profitable. The updated capital and utility estimates have increased in Task 4. The increases are enough to prevent profitable BTX production. As a result, it is recommended that the aromatics recovery unit not be constructed. Figure 3 shows the processing scheme for reference, but with zero flow rates.

A design for BTX production was completed and details are reported in Appendices A and F. The design was necessarily completed before the updated cost data could be fed to the linear program model, which then rejected the naphtha processing as unprofitable.

Phenol Processing--The phenols by-product stream from the Great Plains plant is treated by extraction and distillation to produce phenol, cresols, xylenols, and crude cresylic acids. Approximately 878 barrels of the crude phenol per day are distilled to remove tars and product phenol. Part of the remaining stream, crude cresylic acid, is extracted with hexane and methanol to produce cresols and xylenols.

Details of the phenol processing scheme are given in Appendices A and F, and equipment data and estimate sheets are included in Appendix F.

b. Capital Costs

Capital costs for equipment required for the processing schemes shown in Figure 3 are summarized here. Details are given in Appendix C.

Table 2 summarizes the cost for each section of the processing scheme. The total cost is \$121.4 million, an increase of approximately one third over the estimate provided in Task 1. The increase is reflected primarily in the tar oil hydrotreating section, which now includes an additional hydrotreating vessel and preliminary distillation section. Note that the \$121 million includes the cost of constructing naphtha distillation and hydrotreating equipment and an ARU (aromatics recovery unit) to produce BTX from the raw naphtha stream. The linear programming model shows that BTX production is unprofitable, so that the ARU is not included in the final design basis for the profitable JP-8 case. In the maximum profit case, neither the ARU nor the distillation/hydrotreater sections are included. The costs are given here for completeness.

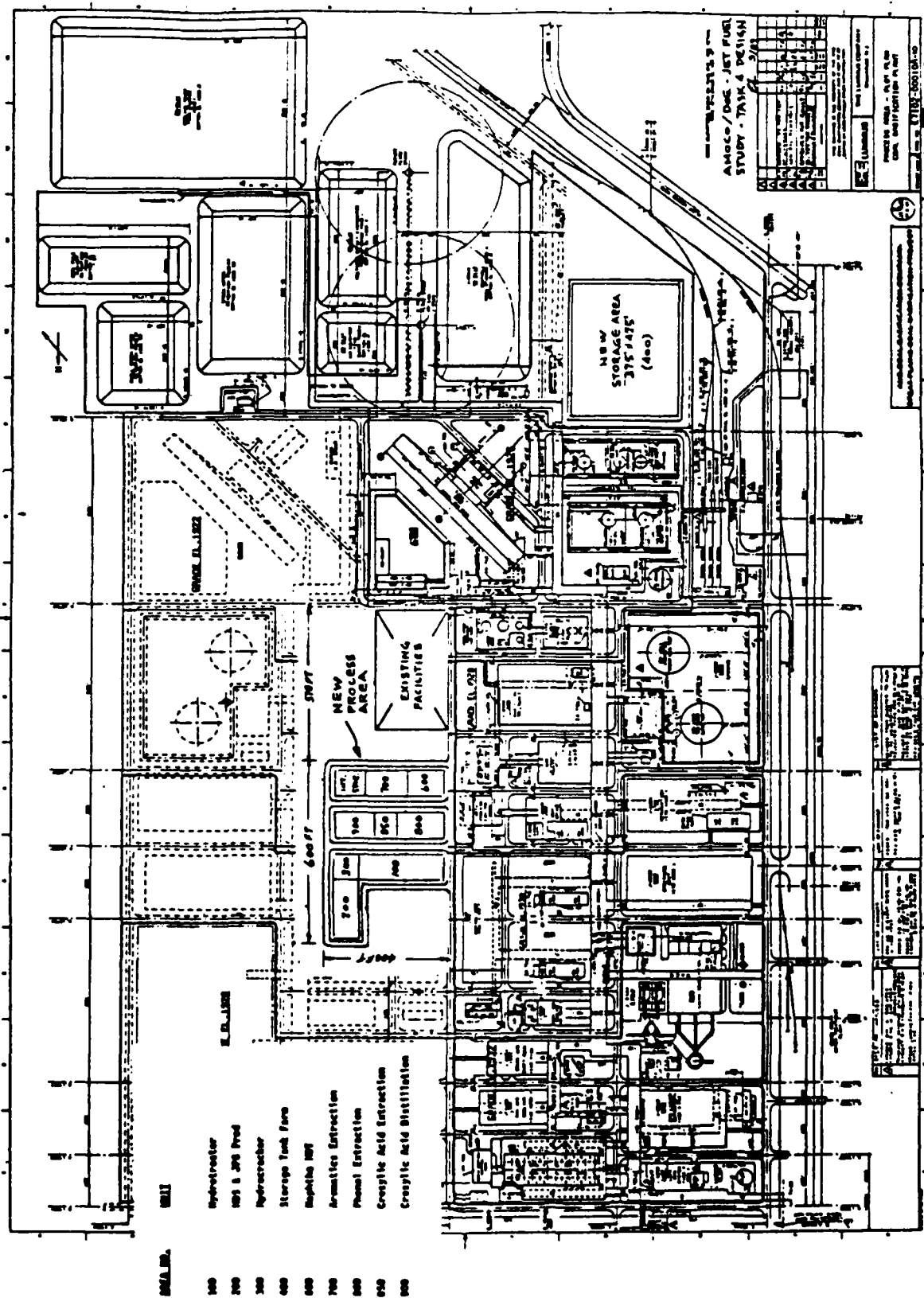
The cost estimates were made at Lummus based on the processing schemes and their return cost data for similar equipment items. The equipment was factored to size and present-day costs based on historical ratios. Engineering costs are included on the basis of the number of equipment items, and a 20% contingency is included in the capital estimates. The estimates do not include spare parts, start-up, insurance, taxes, permits, or royalties on processing technologies.

c. Operating Costs

Costs for labor, utilities, catalysts, chemicals, and maintenance supplies are given in Appendix D. Manpower is allocated at 17 people per shift with maintenance integrated with the existing Great Plains maintenance

TABLE 2
CAPITAL COST SUMMARY

	(Thousands of \$)
Area 100 Hydrotreater	\$ 25,992
Area 200 HDS & JP-8	34,761
Area 300 HDC	5,803
Area 400 OSBL	12,802
Area 500 Catalyst Handling	1,409
Area 600 Naph. Dist & HDT	5,403
Area 700 ARU	10,338
Area 800 Phenol Ext.	11,909
Area 850 Cresylic Acid Ext.	5,361
Area 900 Cresylic Acid Dist	7,508
	<hr/> \$121,287
Area 700 ARU Solvent Invent.	110
Total	<hr/> \$121,397



crew. A total of 87 additional people would be required. Utilities costs total \$93.5 thousand per day, catalysts and chemicals \$2.8 thousand per day, and maintenance supplies \$6 thousand per day.

d. Plot Plan and Tie-ins

Figure 4 shows the integration of the new processing units with the existing Great Plains facilities. The units will be sited in an area 400 by 600 feet east of the existing Rectisol unit. In addition, a storage tank area, approximately 375 by 425 feet, will be required for storage of product and replacement fuel oil. Details of the plot plan are given in Appendix E. Note that the plot plan includes space allocated for the ARU, which was eliminated after formulation of the plot plan.

2. Preliminary Cost and Profitability Estimates

With capital and operating costs provided by Lummus Crest Inc., Amoco Oil Research and Development estimated the cost and profitability of production of JP-8 and other salable products from the Great Plains by-product tar oil, naphtha, and phenol streams. The estimates were made with Amoco's proprietary linear programming models with product values based on in-house expertise, a report by J. E. Sinor,⁽²⁾ and a letter from Burns and Roe Services Corporation to J. G. Masin of Amoco (Appendix G). In addition to the estimates for the "Profitable JP-8 Case," revised profitability estimates for the "Maximum Profit Case," in which no JP-8 is manufactured, are provided for comparison. Also, since the profitability of the cases is sensitive to a number of factors, especially fuel replacement cost and the marketability of specialty chemicals like xlenols, a brief analysis of the effects of changes in those variables is provided.

a. Linear Programming Flowsheets

Amoco's proprietary linear programming models use in-house process expertise and current product values to optimize the configuration and flow rates to the most profitable processing scheme. Figures 5 and 6 are flowsheets for the "Profitable JP-8" and "Maximum Profit" cases, respectively. Note that most of the flow rates are given in units of barrels per calendar day, rather than barrels per stream-day, as in the design schematic (Figure 3).

There are two fundamental differences between the design case, Figure 3, and the optimized linear programming case for profitable JP-8 production, Figure 5. First, the linear programming model is constrained to limit sales of cresols and xlenols, giving lower outputs of those products. Second, increases in the capital cost of the aromatics recovery unit caused the LP to reject construction of the ARU, recommended in Task 1, as unprofitable. These differences are discussed below.

Chemical Sales--Both in the Task 1 and Task 4 studies, chemical sales were limited to 10 percent of the United States market. This limitation is an artificial constraint, and no attempt to define the effect of market penetration on the product value has been included. The effect of relaxing this constraint is discussed later.

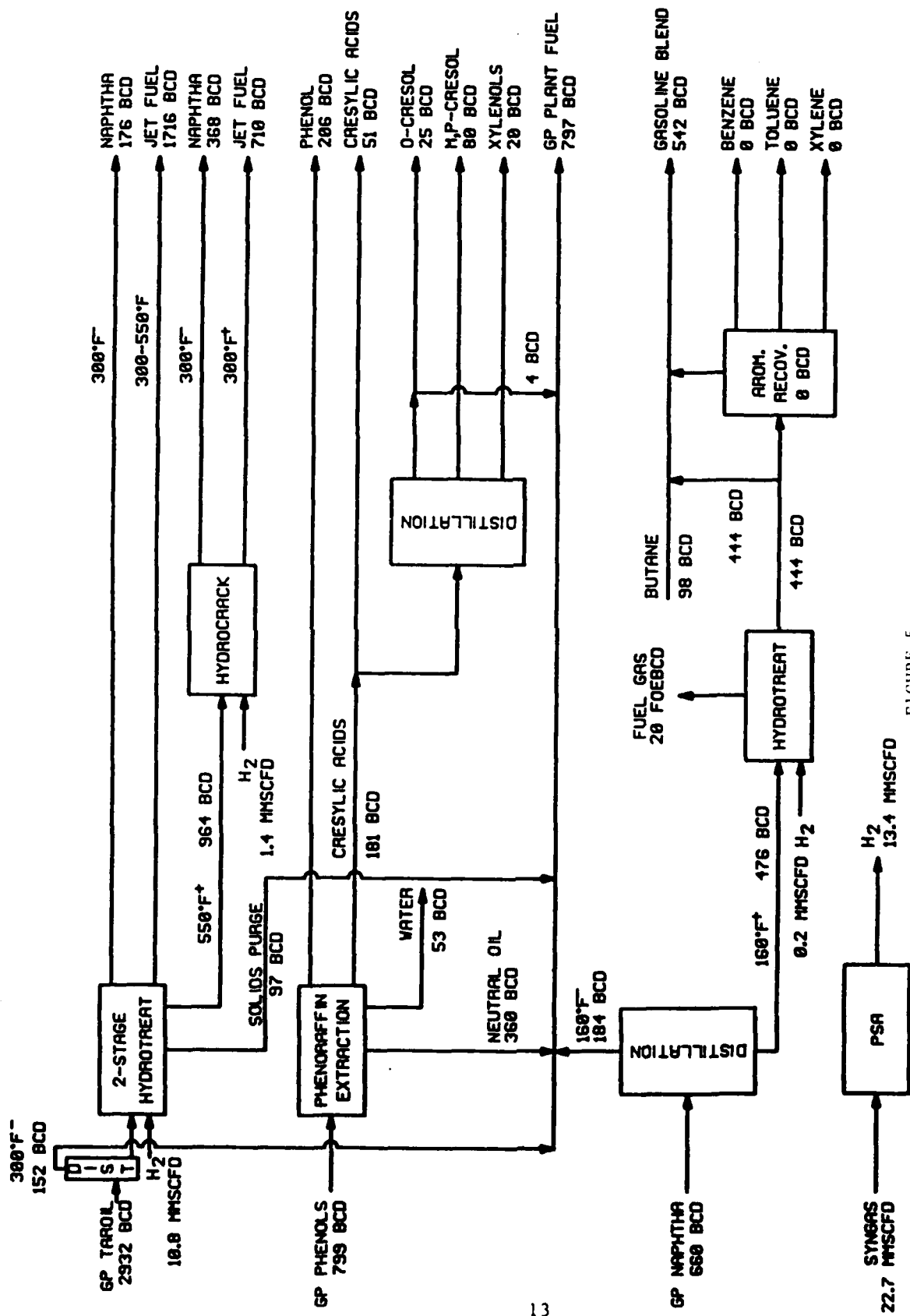


FIGURE 5
GREAT PLAINS CASE 4
BLOCK FLOW DIAGRAM
PROFITABLE JP-8

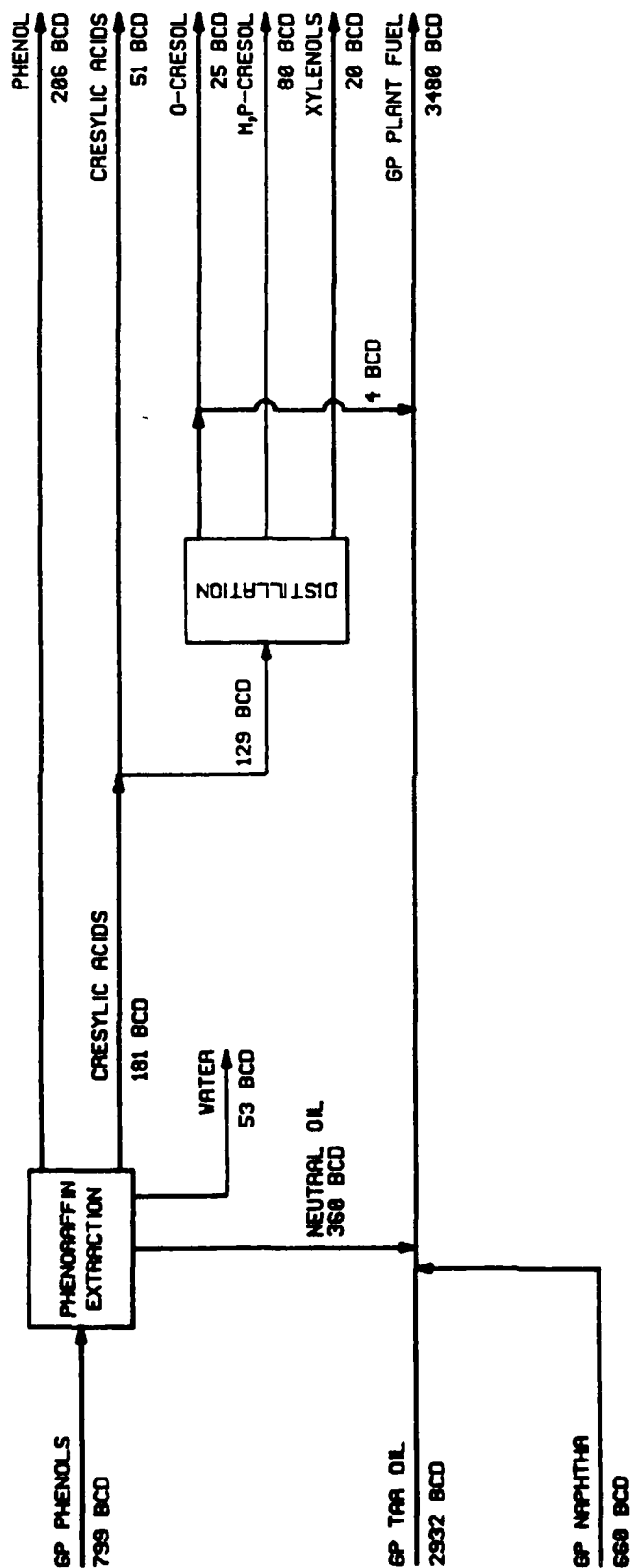


FIGURE 6
GREAT PLAINS CASE 7
BLOCK FLOW DIAGRAM
MAXIMUM PROFIT

TABLE 3
EFFECT OF CHEMICALS SALES LIMITS
MAXIMUM PROFIT CASE

<u>Chemical</u>	<u>Sales Limits, MBCD</u>	
	<u>Sinor</u>	<u>SRI</u>
Benzene	Unlim	Unlim
Toluene	Unlim	Unlim
Xylene	Unlim	Unlim
Phenol (1)	Unlim	2.192
o-Cresol	0.25	0.61
m,p-Cresol	0.80	0.38
Xylenols (2)	0.30	0.485
Cresylic Acids	1.40	
Profit, MM\$/yr (3)	9.2	15.1

(1) Sinor \$80/Bbl, SRI \$157-175/Bbl

(2) SRI broke down into individual isomers

(3) Limit to 10% of cresol and xylenols

The market limits were defined in reports by Sinor⁽²⁾ and SRI (Appendix G). Table 3 summarizes the sales constraints based on information from the cited reports. The Sinor information was used in the Task 1 study; the impact of the SRI values are reported here. Based on the "Maximum Profit" case, the annual profit from sales of chemicals increases from \$9.2 million to \$15.1 million in going to the updated costs. The primary difference, though, is not that the quantity of chemicals sold has changed, but that the value of phenol has doubled from about \$80 per barrel to about \$160 per barrel. The impact of the increased phenol value on the "Profitable JP-8" case is discussed in conjunction with the differences in the capital costs, below.

Differences in Capital Costs--Process data from Tasks 2 and 3 redefined the tar oil processing scheme used in Task 1. More severe hydrotreating is required than assumed in the Task 1 estimates and, as a result, the capital costs for the hydrotreater section increase from \$45.6 million in Task 1 to \$63.2 million in the Task 4 estimate (Table 4). Note that the costs reported in Table 4 include OSBL (outside battery limits) costs and, therefore, are higher than the values reported directly by Lummus (Table 2 and Appendix C), which did not include OSBL. In total, the capital investment for the "Profitable JP-8" case increased from \$85 million in Task 1 to \$110 million, in spite of the elimination of the ARU.

Tables 5 and 6 summarize the effects of the increased capital cost and the impact of the higher phenol value on the "Profitable JP-8" and "Maximum Profit" cases, respectively. Overall, the increase in capital costs if the ARU is included in the processing scheme causes the "Profitable JP-8" case (Table 5 and Figure 5) to drop from a profit of \$4.5 million per year to a deficit of \$7.3 million, at the phenol value used in Task 1, \$80 per barrel. However, at the updated phenol price, \$160 per barrel, the deficit is largely offset. At the higher phenol value, the deficit drops to \$1.3 million per year.

BTX production was only marginally profitable in Task I. Revised operating costs now make it unprofitable. Since BTX production is unprofitable, the by-product naphtha stream is hydrotreated and sent to gasoline blending stock in the "Profitable JP-8" case. Without the ARU, the capital investment for the "Profitable JP-8" case drops from \$124 million to \$110 million, and the case nets a profit of \$500,000 per year. The ARU is shown in Figure 5, but the flow rates are listed as zero. The ARU would not be constructed.

The impacts of the phenol value and elimination of the ARU for the "Maximum Profit" case, Figure 6 and Table 6, are similar to those for the "Profitable JP-8" case. At the lower phenol cost and with ARU construction, the profit drops from \$14.9 million in Task 1 to \$6.6 million in the updated estimate. However, the increased phenol value boosts the profit to \$12.7 million. The ARU is unprofitable at the higher revised cost, so the LP reflects this most profitable case. Note that the "Maximum Profit" design provides for no jet fuel production. Consequently, the only hydrogen requirement is for the naphtha hydrotreater, 205,000 SCF per day. The small volume of gasoline blending stock produced by the naphtha hydrotreater, coupled with the costs of building a pressure swing absorption (PSA) unit to produce the hydrogen, makes the naphtha hydrotreater unprofitable. Therefore, the "without ARU" column in Table 6 reflects elimination of the naphtha hydrotreater, as

TABLE 4

GREAT PLAINS INVESTMENT AND UTILITIES SUMMARY

Unit Investment \$MM	Max Profit		Profit JP-8	
	Task 1	Task 2	Task 1	Task 2
Aromatics Rec	12.3	0	12.3	0
Phenoraffin	19.4	28.1	19.4	28.1
Tar Oil Distil	0	0	0	4.8
Hydrocracking	0	0	11.2	6.3
Hydrotreating	0	0	31.3	52.1
Naphtha Distil	0.2	0	0.2	0.2
Naphtha Hydrotrtg	4.5	0	4.5	6.2
PSA	0.5	0	9.0	10.9
Power Distribution	<u>0.1</u>	<u>0.1</u>	<u>1.4</u>	<u>1.5</u>
Total	37.0	28.2	89.3	110.3
<u>Utilities</u>				
Cat and Chem, \$/D	790	450	1,780	3,430
Fuel, FOEB/D	926	599	4,626	2,502
Power, MW	0.2	0.1	6.8	4.1
Cooling Wtr, Mgpm	0.1	2.8	2.7	6.7
Process Wtr, gpm	2	53	43	90
Steam, MLb/Hr	26.9	0	37.7	62.8

TABLE 5
EFFECT OF TASK 2 AND 3 PROCESS DATA
PROFITABLE JP-8 CASE

	<u>Task 1</u>	<u>Task 4</u>		
		<u>With ARU</u>		<u>W/O ARU</u>
Profit, \$MM/Yr	9.0	-7.3	-1.3	0.5
Capital, \$MM	89.3	123.6	123.6	110.3
<u>Bases</u>				
Phenol Price, \$/B	80	80	160	160
<u>Products, BCD</u>				
Gasoline	306	306	306	925
Reformer Feed	980	353	353	162
BTX	321	334	334	0
JP-8	2,320	2,427	2,427	2,427
Phenol	283	206	206	206
o-Cresol	21	25	25	25
m,p-Cresol	53	80	80	80
Xylenol	30	20	20	20
Cresylic Acids	138	51	51	51

TABLE 6
EFFECT OF TASK 2 AND 3 PROCESS DATA
MAXIMUM PROFIT CASE

	<u>Task 1</u>	<u>Task 4</u>		
		<u>With ARU</u>		<u>W/O ARU</u>
Profit, \$MM/Yr	14.9	6.6	12.7	13.7
Capital, \$MM	37.0	48.6	48.6	28.2
<u>Bases</u>				
Phenol Price, \$/B	80	80	160	160
<u>Products, BCD</u>				
Gasoline	62	62	62	0
Reformer Feed	0	0	0	0
BTX	389	390	390	0
Phenol	283	206	206	206
o-Cresol	21	25	25	25
m,p-Cresol	53	80	80	80
Xylenol	30	20	20	20
Cresylic Acids	138	51	51	51

well as the ARU. In the "Maximum Profit" case the naphtha would be burned as plant fuel.

b. Economics Summary

Tables 7 and 8 summarize the profitability, investment costs, feed and product flow rates, and cash flows for the "Profitable JP-8" and "Maximum Profit" cases. The Task 1 estimates are included for comparison.

Changes in the tar oil processing scheme as a result of the Task 2 and 3 work, refinements in the capital estimates, and changes in the product values have impacted the product slates for both cases (Table 7). Relative to the Task 1 estimates, the "Profitable JP-8" case now produces more gasoline and liquid fuel and produces correspondingly less BTX and naphtha (reformer feed). A tar oil distillation unit is required for preseparation of the 300°F- fraction before hydrotreating; this was not included in the Task 1 designs. In both the "Profitable JP-8" and the "Maximum Profit" cases, there is no aromatics recovery unit. In addition, the "Maximum Profit" case now no longer has naphtha distillation, naphtha hydrotreaters, or PSA units. As a result the product slate for the "Maximum Profit" case shifts slightly toward less chemicals production.

Table 8 summarizes the cash flows for the "Profitable JP-8" and the "Maximum Profit" cases, comparing the Task 1 and the Task 4 estimates. The "Profitable JP-8" case yields an annual total profit of just \$0.5 million now versus \$9.0 million in the Task 1 estimate. The primary changes are lower net income from sales, primarily due to the elimination of the ARU, and the increase in capital costs as a result of the more complex tar oil treatment. The primary cause of decreases in the profitability of the "Maximum Profit" case is the decrease in net sales due to the elimination of BTX and gasoline production from the naphtha stream. Increased capital costs for the Phenoraffin unit are balanced by elimination of the naphtha treatment units, so that capital costs remain about even between Tasks 1 and 4. Fuel costs drop significantly, since the naphtha stream remains in the fuel pool. The net effect is that the profit remains about the same as the original estimate.

c. Economic Sensitivities

The profitability of both the "Profitable JP-8" and the "Maximum Profit" cases varies considerably with the value of the product streams and fuel costs. The former was evidenced above by the impact of revised phenol price structures since the Task 1 report. In this section the effects of the cost of replacement fuels and limitations on cresylic acid and cresol sales are discussed.

Replacement Fuel Costs--Figure 7 shows the impact of replacement fuel costs on the "Maximum Profit" case. Essentially, the effect of fuel cost is unchanged, although the curve is slightly flatter now since the naphtha stream remains in the fuel pool and is not processed. The estimates in Tables 4 through 8 are based on a fuel cost of \$2.15 per million BTU.

TABLE 7

GREAT PLAINS LIQUID BYPRODUCTS CASE SUMMARY

<u>Economics</u>	<u>Max Profit</u>		<u>Profit JP-8</u>	
	<u>Task 1</u>	<u>Task 4</u>	<u>Task 1</u>	<u>Task 4</u>
Profit, \$M/CD	40.9	37.4	24.7	1.3
Profit, \$MM/Yr	14.9	13.7	9.0	0.5
Investment, \$MM	37.0	28.2	89.3	110.3
<u>Feedstocks, BCD</u>				
GP Naphtha	660	0	660	660
GP Phenol	833	799	833	799
GP Tar Oil	0	0	2,896	2,932
Syngas, MMSCFD	0.4	0	23.2	22.7
<u>Products, BCD</u>				
Gasoline	64	0	306	925
Reformer Feed	0	0	980	162
Jet Fuel	0	0	2,320	2,427
BTX	389	0	321	0
Chemicals	525	331	525	382
Liquid Fuel	450	364	456	798
<u>Unit Capacity, BCD</u>				
Aromatics Rec	428	0	355	0
Phenoraffin	833	799	833	799
Tar Oil Distil	0	0	0	2,932
Hydrocracking	0	0	747	964
Hydrotreating	0	0	4,797	4,441
Naphtha Distil	660	0	660	660
Naphtha Hydrtg	476	0	476	476
PSA, MMSCFD	0.4	0	23.2	22.7

TABLE 8
GREAT PLAINS ECONOMICS SUMMARY

<u>Cash Flow, \$M/CD</u>	<u>Max Profit</u>		<u>Profit JP-8</u>	
	<u>Task 1</u>	<u>Task 4</u>	<u>Task 1</u>	<u>Task 4</u>
Net Sales ⁽¹⁾	79.9	55.4	158.5	143.8
Fuel ⁽²⁾	-14.6	0.2	-66.9	-65.2
Cat and Chem	-0.8	-0.5	-5.0	-3.4
Utilities ⁽³⁾	-0.9	-0.7	-7.3	-8.5
MTIO ⁽⁴⁾	-4.1	-3.1	-9.8	-12.1
Fixed Costs ⁽⁵⁾	-2.6	-1.4	-5.2	-4.7
Capital Recov ⁽⁶⁾	<u>-16.4</u>	<u>-12.5</u>	<u>-39.5</u>	<u>-48.7</u>
Total Profit	40.8	37.4	24.8	1.3
Total, \$MM/Yr	14.9	13.7	9.0	0.5

-
- (1) Includes naphtha, gasoline, BTX, and chemicals, less the cost of purchased gasoline blending stocks (e.g., butane).
 (2) Includes Great Plains naphtha, tar oil, phenol, and hydrogen removed from syngas, as well as purchased fuel, less credit for fuel returned to the Great Plains pool. Hydrogen is priced at a premium over fuel value.
 (3) Includes power, steam, process water, and cooling water.
 (4) Maintenance, taxes, insurance, and overhead charges.
 (5) Primarily operating labor.
 (6) 16.1%/year of capital. See Table II for basis.

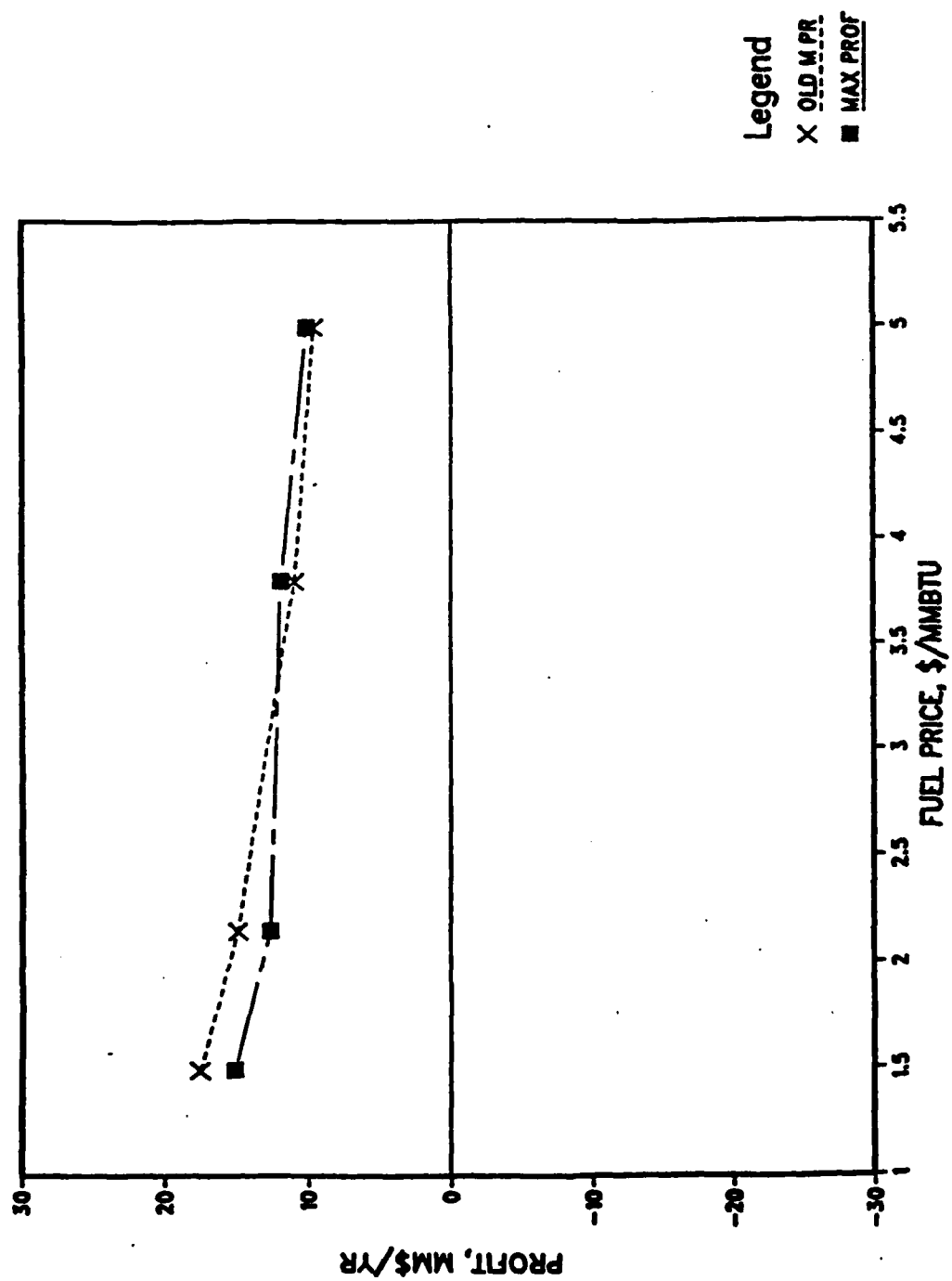


FIGURE 7
MAXIMUM PROFIT CASE
EFFECT OF FUEL PRICE

Effect of Chemical Sales Limitations--Table 9 and Figure 8 show the effect of relaxing the restraints placed on cresol and cresylic acid sales. The profitability estimates reported above are based on cresol and cresylic acid sales limits of 10 percent of the domestic market. The market for these chemicals is small enough so that the Great Plains phenols stream could provide as much as 40 percent of the domestic demand. If the product values held at current levels at all values of percent of U.S. market, the profitability of "Maximum Profit" case would vary according to curves shown in Figure 8. Figure 8 shows the net profit from chemicals sales versus penetration of the domestic cresol and xylenol market. Curves are shown for varying penetrations of the cresylic acids market. Increased market penetration gives increased profits, assuming no change in the product value. Unlimited chemicals sales increase the profitability from \$13.7 million per year for the 10 percent limitations to \$21.3 million per year.

Effect of Chemical Sales Subsidy on JP-8 Cost--Table 10 lists the costs of JP-8 for the "Profitable JP-8" case when the value of the jet fuel is subsidized by chemical sales and when it is not. The value of JP-8 was taken as \$21.84 per barrel for this study. For the subsidized case, the net profitability, \$1,300 per day, was distributed to the 2,427 barrels of JP-8 produced to arrive at a net jet fuel cost of \$21.3 per barrel. The unsubsidized case was calculated by distributing the net increased cost of going from the "Maximum Profit" case, wherein no JP-8 is produced, to the "Profitable JP-8" case. The net increased costs for jet fuel production were \$124,600 per day, the increased capital and operating costs, minus \$35,500, the increased sales from additional chemical and fuel manufactured. This \$89,100 per day increase in cost yields 2,427 barrels per day of JP-8, which would break even at \$36.7 per barrel.

TABLE 9
EFFECT OF CHEMICAL SALES LIMITS

	<u>1 of U.S. Market</u>								
Cresol, Xylenol	0	0	0	10	10	10	20	20	Unl
Cresylic Acids	0	10	20	0	10	20	0	Unl	Unl
<u>Flow Rate, BCD</u>									
Cresol Sales	0	0	0	105	105	55	180	177	231
Xylenol Sales	0	0	0	30	20	10	60	55	114
Cresylic Acid Sales	0	140	280	0	51	280	0	114	0
Fuel Cresol, Xylenol	0	0	0	6	0	0	0	0	0
<u>Unit Capacity, BCD</u>									
Phenoraffin Extract.	799	799	1,167	882	799	1,409	1,027	1,409	1,409
Cresylic Acid Frct	1,304	181	181	181	181	181	242	232	345
Tar Oil Frct	0	0	1,770	399	0	2,932	1,096	2,932	2,932
Dynaphen	181	41	0	62	0	0	0	0	0
<u>Economic Summary</u>									
Investment, \$MM	51.8	49.7	58.2	52.7	48.6	63.4	56.7	64.9	54.6
Profit, \$M/CD	17.6	26.3	35.9	31.7	18.2	44.4	43.0	51.3	58.2
Profit, \$MM/Yr	6.4	9.6	13.1	11.6	6.6	16.2	15.7	18.7	21.3

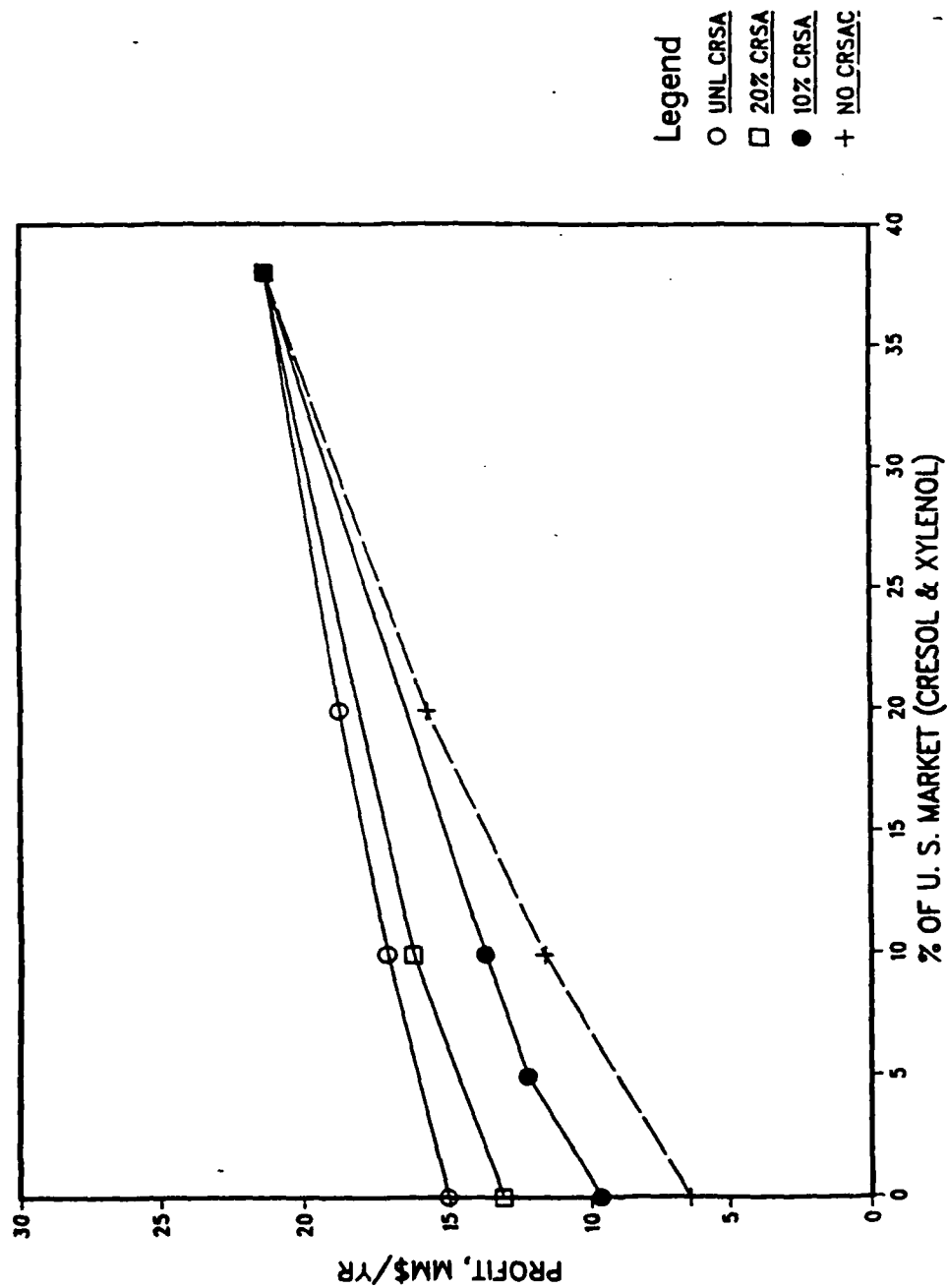


FIGURE 8
MAXIMUM PROFIT CASE
EFFECT OF CHEMICALS SALE

TABLE 10

JET FUEL (JP-8) COSTS

PROFITABLE JP-8 CASE

	<u>\$/Bbl</u>	<u>\$/Gal.</u>
Subsidized by Chemical Sales	21.3	0.51
Unsubsidized	36.7	0.87

SECTION V

TASK 5 RESULTS

Task 5 calls for the recommendation of a 10,000-barrel test run to produce JP-8 from the Great Plains tar oil stream. Lummus Crest Inc. completed this portion of the contract. Their report is included as Appendix H and is summarized here.

1. Production Run Recommendation

Work in Tasks 2 and 3 showed that the first stage of tar oil hydrotreatment requires an expanded bed hydrotreater unit. Two such commercial units exist in the United States, but both are too large to carry out a 10,000-barrel run. Lummus has recommended an alternative approach using a two-stage, fixed-bed hydrocracker system. The tar oil would be treated in five steps:

1. Tar oil hot filtration to remove solids to avoid plugging the first-stage hydrocracker.
2. Hydrocracking at a high recycle rate to handle heat of reaction to lower heteroatom content and to begin aromatics saturation.
3. Fractionation of the hydrotreated products.
4. Recycle hydrocracking of the 550 F+ fraction to extinction.
5. Clay treatment of the blended JP-8 product.

Details of the processing steps are provided in Appendix H.

2. Demonstration Run Facilities

Table 11, excerpted from Appendix H, lists U.S. refineries with hydrocracking capacity which might be able to accomplish a 10,000-barrel run according to the recommended scheme. None of the refineries has been contacted regarding this test, and it is not clear whether any of the facilities would be able to match all the equipment needs of the test. In addition to the refineries listed in Table 11, other options are outlined in Appendix H, including the Wilsonville coal liquefaction facility in Wilsonville, Alabama.

TABLE II

LIST OF REFINERIES WITH HYDROCRACKING CAPACITY

<u>Refinery Name & Address</u>	<u>Contact & Phone</u>	<u>Capacity BPSD</u>	<u>Feed</u>
Tesoro Petroleum Kenai Refinery Box 3691 Kenai, AK 99611	Jose Verdin 907-776-8191	9,000	Residue
Atlantic Richfield Watson Refinery Box 6210 Carson, CA 91749	A. W. Johnson 213-548-8000	22,000	Dist.
Chevron U.S.A. Richmond Refinery Box 1272 Richmond, CA 94802	J. P. Krider 415-620-3000	30,000	Residue
Mobil Oil Torrance Refinery 3700 West 190th St. Torrance, CA 90509-2929	L. K. Williams 213-328-2550	21,700	Dist.
Mobil Oil Beaumont Refinery Box 3311 Beaumont, TX 77704	J. A. Jones 409-883-9411	32,000	Dist.
Texaco Port Arthur Refinery Box 712 Port Arthur, TX 77640	R. E. Anderson 713-982-5711	15,000	Dist.
Texaco Bakersfield Refinery Box 1476 Bakersfield, CA 93302	D. R. Hall 805-326-4200	14,300	Dist.
Texaco Los Angeles Refinery Box 817 Wilmington, CA 90748	R. E. Morris 213-835-8261	20,000	Dist.
Tosco Avon Refinery Martinez, CA 94553	J. M. Cleary 415-228-1220	23,000	Dist.

TABLE II
(Continued)

<u>Refinery Name & Address</u>	<u>Contact & Phone</u>	<u>Capacity BPSD</u>	<u>Feed</u>
Unocal 1660 West Anaheim St. Box 758 Wilmington, CA 90744	A. V. Mandlekar 213-513-7600	22,000	Residue
Texaco Delaware City Refinery Delaware City, DE 19706	R. C. Mifflin 302-834-6000	19,000	
Hawaiian Independent 733 Bishop St. Suite 3000, Box 3379 Honolulu, HI 96813	Everett Lewis 808-547-3222	16,000	Residue
Clark Oil, Blue Island Division of APEX Oil 8182 Maryland Ave. St. Louis, MO 63105	S. A. Goldstein 314-889-9600	9,500	Dist.
Marathon Robinson Refinery Robinson, IL 62454	K. N. Warren 618-544-2121	23,000	Dist.
Kerr-McGee Wynnewood Refinery Box 305 Wynnewood, OK 73098	John L. Ray 405-665-4311	5,000	Dist.
Total Arkansas City Refinery 1400 South M St. Arkansas City, KS 76005	Jack Hazen 316-442-5100	3,200	Dist.
Exxon Baton Rouge Refinery Box 551 Baton Rouge, LA 70821-0551	D. H. Daigle 504-359-7711	24,000	Dist.
Exxon Billings Refinery Box 1163 Billings, MT 59103-1163	J. A. MacFarlane 406-657-5380	4,900	Dist.
Exxon Benica Refinery 3400 East 2nd St. Benica, CA 94510-1097	D. L. Wiggins 707-745-7011	29,500	Dist.

TABLE II
(Concluded)

<u>Refinery Name & Address</u>	<u>Contact & Phone</u>	<u>Capacity BPSD</u>	<u>Feed</u>
Sohio 1150 South Metcalf St. Lima, OH 45804	P. Oves 419-226-2300	23,000	Dist.
Sohio Toledo Refinery Box 696 Toledo, OH 43964	J. T. Jacobson 419-698-6408	35,000	Dist.
Sohio Marcus Hook Refinery Box 428 Marcus Hook, PA 19061	J. M. Gibson 215-499-7000	21,000	

SECTION VI

CONCLUSIONS

Experimental studies in Tasks 2 and 3 showed the need for more severe hydrotreating and hydrocracking to produce jet fuel from the Great Plains tar oil than was anticipated in formulating cost estimates in Task 1. Consequently, the profitability of producing jet fuel and other by-products dropped from \$9.0 million per year to \$0.5 million per year.

BTX production is no longer profitable in either the "Profitable JP-8" or "Maximum Profit" cases, due to increases in the cost of a small-capacity aromatics recovery unit.

Profitability of chemicals production is improved by new estimates of the value of phenol, which increased from \$80 per barrel in Task 1 to \$160 per barrel today. The increase in phenol value offsets the increased capital costs for the "Maximum Profit" case nearly completely.

A demonstration run to produce 10,000 barrels of JP-8 jet fuel would require modifications to the processing scheme recommended in Task 3. No existing commercial expanded-bed hydrotreater would be suitable for the work. However, the work could probably be carried out in a fixed-bed hydrocracker unit at high recycle rates. Production facilities have been recommended.

SECTION VII

RECOMMENDATIONS

Before a production run can be carried out, contact with a number of refining facilities will be required to assure that their facilities can accomplish the work.

The profitability of the chemicals or jet fuel production schemes discussed in this report is highly dependent on fuel and product values and changes in construction costs. Profitability will vary dramatically, as evidenced by the changes in the estimates over the year elapsed between Task 1 and Task 4. Caution should be exercised in utilizing the estimates presented herein.

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1. Smith, E. B., "Jet Fuels from Coal; Third Quarterly Report," U.S. Department of Energy Research Contract No. DE-FC21-86MC11076, May 1987.
2. Sinor, J. E., "Production of Jet Fuel from Coal-Derived Liquids, Vol 1, Market Assessment for Liquid By-Products from the Great Plains Gasification Plant," AFWAL-TR-87-2042, August 1987.
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6. Gary, J. H., and G. E. Handwerk, "Petroleum Refining Technology and Economics," Marcel Dekker, Inc., 1984, page 140.

APPENDIX A

LCI Report on "Profitable JP-8" Design:
Case Description

1.0 CASE DESCRIPTION

1.1 Overall Process Description

The purpose of this design basis is to produce JP-8 type aviation turbine fuel and chemical byproducts to maximize profit from Great Plains liquid by products. Figure 1 presents a block diagram for the process and referring to Figure 1 the flow is as follows:

- . The total Tar Oil byproduct stream (47,670 #/hr, 3222 BPSD) is first fractionated in the Preflash Tower into a 300°F- stream which is sent back to the main boiler in the SNG plant, and a 300°F+ stream which is charged to the expanded bed hydrotreater.
- . The hydrotreater is a 3 stage expanded bed type process which removes over 98% of the sulfur, nitrogen, and oxygen compounds and begins the conversion of 525°F+ material. The hydrotreater adds a large quantity of hydrogen to the feed (3073 SCF/bbl) which results in a high heat of reaction. An expanded bed type reactor was chosen to both control and utilize the heat of reaction. Three stages were used to both control the temperature rise as well as to obtain the high efficiency associated with staging a back-mixed reactor.
- . The hydrotreater produces 6 streams:
 - A low pressure fuel gas stream (25 psig) which is a mixture of recycle PSA off gas, atmospheric tower overhead gas, as well as overhead gas from Area 200 fractionation.
 - Very low pressure fuel gas (2 psig) which is sent to the low pressure burner.
 - Unstabilized naphtha which is sent to the combined naphtha stabilizer in the HDS unit (Area 200). After stabilization, to control vapor pressure, the naphtha is sent to storage and gasoline blending.
 - A 200°F+ stream (atmospheric bottoms) containing most of the hydrotreater liquid product, which is sent to the HDS unit (Area 200).
 - A solids laden vacuum bottoms product which is sent to the battery limits.
 - Wastewater containing NH₄OH and NH₄HS which is sent to the PHOSAM unit in the SNG plant for recovery of the H₂S and NH₃.

LCI PROJECT 5571
TASK 4.0

- Approximately 950 #/day of spent catalyst which is shipped to a catalyst reclaimer in the same drums that the catalyst is received in.
- . The 200⁰F+ stream from the expanded bed hydrotreater (Area 100) is charged to the HDS unit (Area 200).
- . The HDS and JP-8 Fractionation Unit (Area 200) follows the expanded bed hydrotreater. Here the sulfur and especially nitrogen removal is continued to levels compatible with the catalyst in the hydrocracker. In the fractionation section the liquid products (JP-8 and light naphtha) from this plant are stabilized, as well as the hydrotreater naphtha.
- . The unit produces 7 streams:
 - A high pressure purge gas which is sent to the recycle compressor in Area 100.
 - Off gas from both the JP-8 tower and the naphtha stabilizer which are sent to Area 100 to be compressed for fuel gas.
 - Off gas from the LP Separator, sent to either fuel gas, or PSA off gas.
 - A stabilized light naphtha stream sent to storage.
 - Stabilized JP-8 sent to storage.
 - A nonconverted 525⁰F+ stream (fractionator bottoms) which is sent to the fixed bed hydrocracker (Area 300).
 - A sour water stream sent to Area 100.
- . The Hydrocracker Unit (Area 300) converts the 525⁰F+ material to naphtha and JP-8 turbine fuel. For this service a 5 stage unit was chosen with 65% conversion per pass.
- . The hydrocracker produces 3 streams:
 - High pressure purge gas (approximately 90% hydrogen) which is sent to the recycle compressor in Area 100.
 - A combined liquid stream which is sent to the fractionation tower in Area 200.
 - A small sour water stream which is sent to Area 100.

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TASK 4.0

- . Hydrogen make-up for all three units; Hydrotreater, HDS and Hydrocracker as well as the Naphtha Hydrotreater (Area 600) is supplied from a PSA Hydrogen Unit. High pressure (355 psig) synthesis gas from the Rectisol Unit (which contains about 63% hydrogen) is charged to the PSA unit which recovers 86% of the contained hydrogen as a high pressure 99.99% purity hydrogen gas product. The remaining purge gas is available at low pressure (5 psig) and has a fuel value of about 565 BTU/ft³. This H₂, CO & CH₄ rich gas is recompressed into the methanation unit of the SNG plant.
- . The crude naphtha byproduct stream (8738#/hr, 725 BPSD) is charged to the distillation and hydrotreating unit (Area 600).
- . The distillation removes the material boiling below 160°F, which is sent to the SNG plant fuel pool, and produces a bottoms product which is charged to the hydrotreater.
- . The fixed bed hydrotreater is a single bed reactor which removes 99% + of the sulfur, nitrogen and oxygen compounds. Hydrogen is added to the feed at the rate of 430 SCF/bbl.
- . The naphtha hydrotreater produces 4 streams:
 - High pressure purge gas (approximately 90% hydrogen) which is sent to the Rectisol Unit in the SNG plant for recovery of the H₂ and CH₄.
 - Naphtha which is stabilized to control vapor pressure, and then sent to the aromatics recovery unit (Area 700).
 - A low pressure off gas which is sent to the Stretford unit in the SNG plant.
 - Wastewater containing, NH₄OH and NH₄HS which is sent to the PHOSAM unit in the SNG plant for recovery of the H₂S and NH₃.
- . The hydrotreated naphtha is charged to the extraction section of the Aromatics Recovery Unit (Area 700) where it is contacted with a solvent to extract the aromatic components from the stream. The raffinate is sent to storage and gasoline blending while the solvent is recovered from the aromatic extract. The aromatic extract is then sent to fractionation to produce the BTX products.
- . Five streams are produced in the Aromatics Recovery Unit.
 - A hydrocarbon gasoline blending stock which is sent to storage and gasoline blending.

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- A small process water stream which is sent to the waste treatment plant in the SNG plant.
- Three product streams Benzene, Toluene and Xylene which are sent to storage.
- . The crude phenol byproduct stream (13,550 #/hr, 878 BPSD), is fed to the crude phenol processing units.
 - Area 800 : Phenol Extraction
 - Area 850 : Cresylic Acid Extraction
 - Area 900 : Cresylic Acid Distillation
- . In the Phenol Extraction Area (800) the crude phenol is first distilled to remove the tar (approximately 35% of the feed) and secondly fractionated to remove the phenol and cresylic acid from the light ends cut. The light ends cut is fractionated to recover the entrained phenol.
- . The phenol and cresylic acid stream is flashed in a thin film evaporator over a concentrated sulfuric acid mixture to remove pyridine type substances. The vapor phase is dried and then distilled to extract phenol from the cresylic acid mixture.
- . The phenol product is purified with steam and sent to storage. The resulting cresylic acid mixture is sent to Section 850.
- . The tars produced are water washed and sent to fuel.
- . Streams produced in the Phenol Extraction Area are:
 - Phenol product sent to storage
 - Cresylic acid mixture sent to Section 850
 - Tar product sent to storage and fuel for the SNG plant boilers.
- . The remaining cresol/xlenol mixture is sent to the Cresylic Acid Extraction Area (850) where it is double solvent (hexane and methanol) extracted to remove neutral hydrocarbons. The resulting crude cresylic acid is dried and sent either to storage or distillation (Area 900).
- . The solvents are re-extracted by distillation and recycled to the extractor column.

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- . Streams produced in the Cresylic Acid Extraction Area are:
 - Neutral Oil mixed with Tars from 800 Area
 - Crude Cresylic Acid sent to distillation (Area 900) or intermediate storage
- . The Crude Cresylic Acid is sent to Cresylic Acid Distillation (Area 900) where it is progressively distilled in a 2 block operation scheme.
- . Block operation 1 extracts M/P Cresol product, Crude Phenol, o-Cresol and Mixed Xylenol streams:
- . Block operation 2 extracts o-Cresol, 2,4/2,5 Xylenols and Mixed Xylenol products and slop cut stream.
- . Streams produced in the Cresylic Acid Distillation Area are:
 - O-Cresol product sent to storage
 - M/P Cresol product sent to storage
 - 2,4/2,5 Xylenols and Mixed Xylenols products sent to storage
 - Slop cut mixed with the Tar product from Area 800.
 - A Crude Phenol stream which is recycled to Area 800.

1.2 Overall Material Balance

The overall material balance which is presented below presents the overall material balance for the major process units computed on the basis that the fuel value of the feed will be replaced by fuel gas, tar oil and 160°F- distillate produced in the process and the difference made up by the purchase of #6 Fuel Oil. Detailed Material Balances for each process area are presented in Section 2 with the Process Flow Diagrams.

The overall balance is as follows:

Feeds

3222	BPSD of Tar Oil
878	BPSD of Crude Phenol
725	BPSD of Crude Naphtha
4290	BPSD of #6 Fuel Oil
11.07	MMSCFD equivalent SNG product loss due to the syngas feed to the PSA unit

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Products

2662	BPSD of JP-8 turbine fuel
162	BPSD of 300°F - Naphtha for gasoline blending
813	BPSD of stabilized naphtha
226	BPSD of Phenol
45	BPSD of o-Cresol
124	BPSD of m,p-Cresol
13	BPSD 2,4/2,5 Xylenols
18	BPSD of Mixed Xylenols
395	BPSD of Tar Oil for Fuel
202	BPSD of 160°F- Distillate for Fuel
46	BPSD of Gasoline Blending Stock
315	BPSD of Benzene
112	BPSD of Toluene
15	BPSD of Xylene
6.94	MMSCFD equivalent SNG product credit due to HDT, & PSA purge gas reinjection into SNG plant.

Net Changes in Boiler Fuel Fired

Fuel	#hr	BTU/#	MMBTU/hr	MMSCFD	BTU/ft ³	BPSD
Tar Oil	-47670	17000	-810.4			- 3222
Crude Phenol	-13550	13070	-177.1			-878
Crude Naphtha	-8738	18500	-161.7			-725
Fuel Gas	3940	18000	70.9	2.19	777	
160°F- distillate	2164	17400	37.7			202
Tar Oil	6117	15000	91.8			395
Import Steam	89000	710	-63.2			
Fuel Oil to Boiler	56222	18000	1012.			4061
Total			0.0			
Fuel Oil to Process Heaters	3172	18000	57.1			229

Net Changes in SNG Production

	EQV SNG MMSCFD	PSA/Purge Gas #Mol/SD
SNG equivalent of Syn Gas to PSA	11.07	75443
SNG Credit for PSA Purge Gas	6.92	34388
SNG Credit for Hdtrs Purge Gas	0.02	163
Total SNG Production Loss	4.13	

1.3 Overall Utility Balance

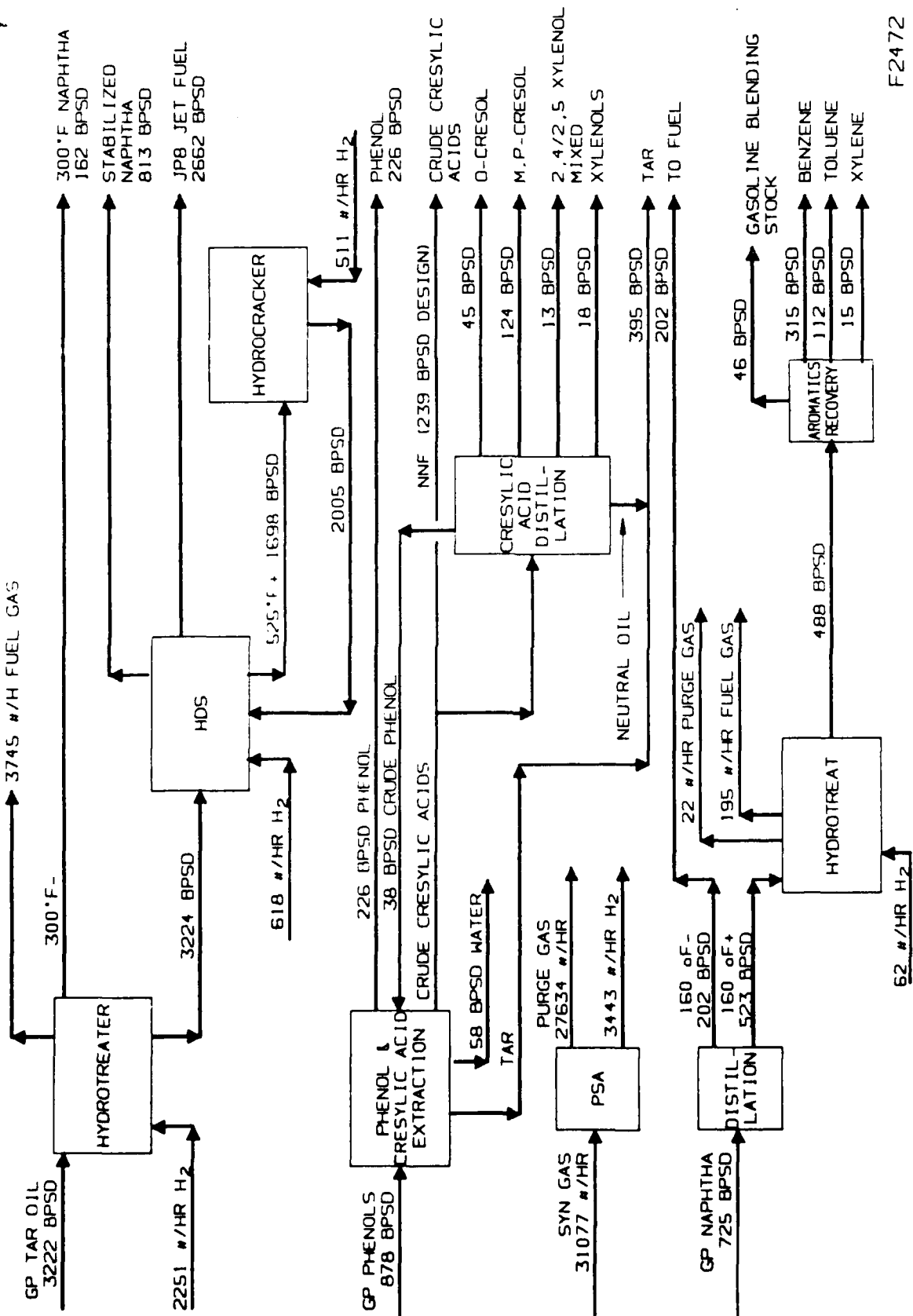
The overall utility consumption of the complex is as follows:

#6 Fuel Oil	4290 BPSD
SNG Equipment of Syn Gas & Purge Gas	4.13 MMSCFD
Power	7950 kW
Cooling Water	8860 GPM (30°F rise)
Process Water	100 GPM

In addition the process utilizes steam as summarized below which was debited against boiler requirements.

HP Steam Import	70,000 #/H
MP Steam Import	34,500 #/H
LP Steam Export	15,090 #/H
Condensate Return	101,500 #/H
Boiler Feedwater Import	13,000 #/H

FIGURE 1: PROFITABLE JP-8 DESIGN



F2472

APPENDIX B

LCI Report on "Profitable JP-8" Design:
Process Description

2.0 PROCESS DESCRIPTION

2.1.1 Hydrotreater (Area 100)

2.1.1.1 Reaction Section

Operating conditions for the hydrotreater were provided to Lummus by Amoco⁽¹⁾ and these conditions are presented in Table 2.1.1. This information was supplemented by LCI's calculated product properties and detailed yield and elemental balances (2). The basic processing step selected was the expanded bed hydrotreater (LC Fining) system. Due to the extremely high exothermic heat of reaction it was necessary to use 3 reactors with interstage cooling. Referring to Process Flow Diagram E5571-101 the flow is as follows:

- . Feed Tar Oil from battery limits is delivered into the Day Tank FA-101, from where it is charged to the Preflash Tower DA-101 through Pump GA-114 and Preflash Heater BA-101.
- . In DA-101 the Feed Tar Oil is stripped of 300⁰F- components which are sent back to the SNG plant to be used as fuel.
- . The 300⁰F+ part, which represents the bulk of the Tar Oil is charged into the hydrotreater through Feed Pump GA-101. The charge oil is combined with feed hydrogen gas prior to entering Feed Heater BA-102. The preheated mixture is then charged to the First Reactor DC-101.
- . The Expanded Bed Reactor DC-101 approaches isothermal conditions in which the heat of reaction is used to heat the feed up to 760⁰F.
- . The effluent from DC-101 is cooled with both the quench gas from the Recycle Gas Compressor GB-101 as well as the quench naphtha from GA-102. The combined mixture is charged into the Second Reactor DC-102.
- . The effluent from DC-102 is cooled in the same manner as the previous effluent and is then charged to the Third Reactor DC-103.
- . The effluent from DC-103 flows to the High Pressure/High Temperature Separator FA-102. Both the vapor and the liquid from FA-102 are let down (to 385 psig) to the Low Pressure/High Temperature Separator FA-103. This design uses the LCI patented and commercially proven low pressure hydrogen recovery scheme.

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Hot liquid from FA-103 flows to the Vacuum Tower DA-103 for solids removal. The vapors from FA-103 flow through exchangers EA-103 and EA-104 (H.P. steam generator and BWF preheater) and then are flashed in the Low Pressure/Intermediate Temperature Separator FA-104.

The vapors from FA-104 flow through Air Cooler EC-101 where they are cooled to 120°F. Process water is injected upstream of EC-101 to convert the H_2S and NH_3 in the gas to an aqueous NH_4OH/NH_4HS solution. From EC-101 the vapor and liquid stream enter the Low Pressure/Low Temperature Separator FA-105. The hydrocarbon liquid from FA-105 is joined by the liquid from FA-104 and the combined stream is fed to the Atmospheric Tower Feed Surge Drum FA-109.

The gas stream is sent to Recycle Gas PSA Unit PA-104. The resulting 99.99% pure hydrogen stream is combined with a portion of the gas that bypassed the PSA unit and together with high pressure purge gas from Areas 200 and 300 enters the Recycle Gas Compressor GB-101, where it is recompressed to reaction level pressure.

At the compressor discharge the recycle gas stream is joined by the hydrogen make-up stream from Area 200.

The PSA unit off gas (at about 5 psig) is combined with other low pressure gases from Area 200, and after compression to fuel gas header pressure in the Fuel Gas Compressor GB-102 and subsequent cooling in Fuel Gas Cooler EA-107, is sent to the boiler plant as fuel gas.

The water phase from FA-105 joins other sour water streams from Areas 100, 200 and 300 and is sent to the PHOSAM unit in the SNG plant to recovery H_2S and NH_3 .

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Table 2.1.1 Hydrotreater Conditions

Reactor Type	Expanded Bed
Number of Reactors	3
Catalyst Addition Rate Lbs/Bbl	0.2 (1/3 per Reactor)
Reactor Temperature	760°F
Reactor Pressure	
(Outlet 3rd Reactor)	2225 psia
Heat Release, Btu/Bbl	80,150 per Reactor
Hydrogen Chemical	
Consumption SCF/BBL	3073
Ratio of H ₂ in feed to	
Chemical H ₂	2.0 min.
Catalyst Type	Shell 324 M (NiMo)

2.1.1.2 Fractionation Section

Referring to Process Flow Diagram E5571-102 the flow is as follows. The hot liquid from FA-103 is fed to a refluxed Vacuum Flash Tower DA-103. Here a concentrated (with approximately 30% solids) bottoms stream is withdrawn and sent to battery limits for disposal.

- The top vapor is partially condensed with BFW in the HVGO Condenser/BFW Exchanger EA-101, generating both reflux and a heavy gas oil product stream.
- From the HVGO Accumulator FA-106 the LVGO vapor is condensed in the LVGO Condenser EA-102 and is pumped together with the HVGO stream to the Atmospheric Tower Feed Surge Drum FA-109.
- The vapor off the LVGO Accumulator FA-107 (mainly non-condensable gas) is directed to the Vacuum System PA-101.
- From the Vacuum Hotwell FA-108, a low pressure fuel gas is sent to a special burner in BA-101. The vacuum system uses medium pressure steam. The steam condensate is pumped out by the Sour Water Pump GA-106. This stream with all other sour water streams originating in Areas 200 and 300, is directed to the PHOSAM unit.

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The hydrocarbon liquid streams from FA-104 and FA-105 as well as the two vacuum gas oil streams are all combined in the Atmospheric Tower Feed Surge Drum FA-109. Both the vapor and liquid are fed to the Atmospheric Tower DA-102. This tower is reboiled by high pressure steam in the Atmospheric Tower Reboiler EA-105. The tower is provided with a water cooled, Atmospheric Tower Overhead Condenser EA-106 which generates both reflux and a light naphtha product. Both the overhead naphtha and the hot bottoms are sent to the HDS unit (Area 200) where the former is stabilized, while the latter represents the unit feed.

2.1.2 HDS and JP-8 (Area 200)

2.1.2.1 Reaction Section

The operating conditions for the Hydrotreater, were given by Amoco (1) and presented in Table 2.1.2. This information was supplemented by LCI's calculated product properties (2). Certain parameters such as unit pressure and hydrogen recycle rate had to be increased by LCI in order to achieve a satisfactory hydrogen partial pressure. As shown on the Process Flow Diagram E5571-201 the flow is as follows:

- . Hot atmospheric tower bottoms from Area 100 flow to the HDS Feed Surge Drum FA-201, from where the HDS Feed Pump GA-201 pumps the feed to the HDS reactor loop.
- . Make up hydrogen from the rectisol unit (see composition in Table 2.1.3) for all three hydroprocessing units is being purified in a PSA unit (PA-201) located in Area 200.
- . At the conditions given a 10 bed PSA unit will recover 86% wt. of the hydrogen in the feed according to the manufacturer, Union Carbide EP&P Division.
- . The system uses 10 absorption vessels which are sequenced through adsorption, depressurization, purging, and repressurization steps. The process continuously produces product and purge gas (see composition in Table 2.3). It is purchased as a skid mounted unit and the control of the unit is fully automated. Drawing 5571-203 presents a schematic of a Union Carbide Polybed PSA unit.
- . The unit, PA-201, selectively absorbs all components except H₂ and produces a 99.99% vol. purity stream at about 345 psig and 80°F.

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TASK 4.0

- . This hydrogen stream is compressed in the Make-up Hydrogen Compressor GB-202 to a pressure high enough to satisfy all four hydroprocessing unit pressure levels.
- . A controlled amount of make-up hydrogen joins the HDS recycle gas stream and together with the hydrocarbon feed enter the reaction loop.
- . This reactor feed mixture is first preheated against reactor effluent in the HDS reactor Feed Effluent Exchanger EA-201, then heated in the HDS Feed Heater BA-201 after which it enters the HDS Reactor DC-201. Cold recycle gas is introduced as quench gas between the two reactor beds.
- . The reactor effluent after being cooled in EA-201 passes through the HDS Reactor Effluent Condenser EC-201 where all the liquid reaction products are condensed. Prior to entering EC-201 wash water is injected into the hydrocarbon stream to convert H_2S and NH_3 present to an aqueous NH_4OH/NH_4H solution. From EC-201, the vapor and liquid enter the HDS Reactor Effluent HP/LT Separator FA-202. The hydrocarbon liquid is pressured to the fractionation section. Sour water is pressured to Area 100.
- . The vapor is compressed in the HDS Recycle Gas Compressor GB-201 and joins the reactor hydrogen make-up, as treat gas. Part of the recycle serves as reactor interbed quench gas.

Table 2.1.2 HDS Reactor Operation

Reactor Type	Fixed Bed
Number of Reactors	1
Number of Beds/Reactor	2
Catalyst per Bed	Bed 1 1/3 Bed 2 2/3
WHSV - HR ⁻¹	1.0
Hydrogen Chemical	
Consumption SCF/Bbl	608
Reactor Pressure (outlet)	2400 psia
H ₂ Partial Pressure @ Outlet	1709 psia
H ₂ Recycle Rate SCF/Bbl	1836 (excluding quench)
Heat Release BTU/Bbl	41660
Catalyst Type	Shell 354 (NiW)

Table 2.1.3 PSA Unit Feed and Purge Gas Properties

Feed Gas (from Rectisol Unit)

Pressure	355 psig	
Temp.	65°F	
Composition		Mol%
H2		63.19
CO		18.61
CO2		1.48
CH4		16.21
C2H6		0.31
COS, H2S, CS2	<	0.01
N2 + Ar		0.19
H2O	<	0.01

Purge Gas

Pressure	5 psig	
Temperature	100°F	
Composition		Mol %
H2		19.32
CO		40.76
CO2		3.24
CH4		35.51
C2H6		0.69
N2+Ar		0.41
Others		0.06

LCI PROJECT 5571
TASK 4.0

2.1.2.2 Fractionation Section

Referring to Process Flow Diagram E5571-202 the flow is as follows.

- . HP/LT separator liquids from both the HDS unit (FA-202 in Area 200) and the HDC Unit (FA-302 in Area 300) are pressured to the JP-8 Tower Feed Surge Drum FA-204.
- . Flash gas is sent to fuel, while the liquid after preheat against JP-8 tower bottoms in the JP-8 Tower Feed/Effluent Exchanger EA-202 is further heated in the JP-8 Tower Feed Heater BA-202 and sent to the JP-8 Tower DA-201.
- . In this tower JP-8 is taken as a sidestream (with an approximate TBP range of 280 - 525°F), and all the unconverted 525°F+ material leaves the tower as bottoms.
- . The overhead product naphtha is sent to naphtha stabilization. Since this is a steam stripped tower and so is the JP-8 Product Stripper DA-202, the sour water generated in the JP-8 Tower Overhead Reflux Drum FA-205 is sent to Area 100 (to the suction of GA-106) to be pumped back to the SNG plant.
- . The JP-8 is steam stripped in DA-202, and after serving as a heating medium in the Naphtha Stabilizer Reboiler EA-205, is cooled in the JP-8 Product Cooler EC-202 and sent to storage.
- . The naphtha from FA-205 is joined by light naphtha from Area 100, preheated in the Naphtha Stabilizer Feed/Bottoms Exchanger EA-204, and fed to the Naphtha Stabilizer DA-203.
- . Here most of the C₄ hydrocarbons are stripped out of the naphtha and joining the overhead gas from the JP-8 Tower DA-201, are sent to Area 100 to be compressed to fuel gas pressure.
- . The stabilized naphtha bottoms product after being cooled by exchanger with feed in EA-204 is cooled to storage temperature in the Stabilized Naphtha Cooler EA-207.
- . The 525°F+ material leaves the JP-8 tower bottoms and is pumped by GA-204 and cooled by EA-202 before being sent to the Hydrocracker (Area 300).

LCI PROJECT 5571
TASK 4.0

2.1.3 Hydrocracker (Area 300)

The operating conditions for the Hydrocracker were provided to Lummus by Amoco⁽¹⁾ and these conditions are presented in Table 2.1.4. This information was supplemented by LCI's calculated product properties and detailed elemental balances (2). The basic processing step is a five bed hydrocracking reactor with interbed quench. Referring to Process Flow Diagram E5571-301 the flow is as follows.

- . The 525°F+ material (JP-8 tower bottoms from Area 200) is fed to the HCR Feed Surge Drum FA-301, from which it is pumped via HCR Feed Pump GA-301, mixed with recycle gas, preheated in the HCR Reactor Feed/Effluent Exchanger EA-301 and HCR Feed Heater BA-301 before being charged to the Hydrocracker Reactor DC-301.
- . The five bed hydrocracker is quenched with recycle gas between stages to control the bed temperature. The hydrocracker has a conversion of 70% per pass.
- . The HCR reactor effluent mixed phase is cooled in HCR Feed/Effluent Exchanger EA-301, injected with water to convert the H_2S and NH_3 present to an aqueous NH_4OH/NH_4HS solution, and then enters EC-301 where all liquid reaction products are condensed. The vapor liquid mixture enters the HCR HP/LT Separator FA-301 from which the hydrocarbon liquid is pressured back to the JP-8 tower feed stream in Area 200.
- . The sour water phase in the HP/LT Separator is sent to the SNG plant Phosam unit with the Area 100 and 200 sour water streams.
- . The vapors from the HP/LT Separator are sent to the HCR Recycle Gas Compressor GB-301 via FA-303 K.O. Drum. A purge stream is extracted from this stream to control the contaminants and sent to Area 100. The GB-301 Recycle Compressor effluent is partially used as quench gas for the HCR Reactor. The remaining gas is mixed with fresh makeup hydrogen and combined with the HCR Reactor liquid feed stream.

LCI PROJECT 5571
TASK 4.0

Table 2.1.4 HCR Operating Conditions

Reactor Type	Fixed Bed
Number of Reactors	1
Number of Beds/Reactor	5
Catalyst per Bed	10% Bed 1 22.5 % Beds 2-5
WHSV, HR^{-1}	0.7
Hydrogen Chemical Consumption	SCF/BB1 1123
Reactor Pressure (outlet)	1700 psia
H ₂ Partial Pressure (outlet)	1441 psia
Hydrogen Recycle Rate SCF/BB1	6973 (excluding quench)
Heat Release BTU/BB1	84806
Catalyst Type	Davison SMR 6-1881

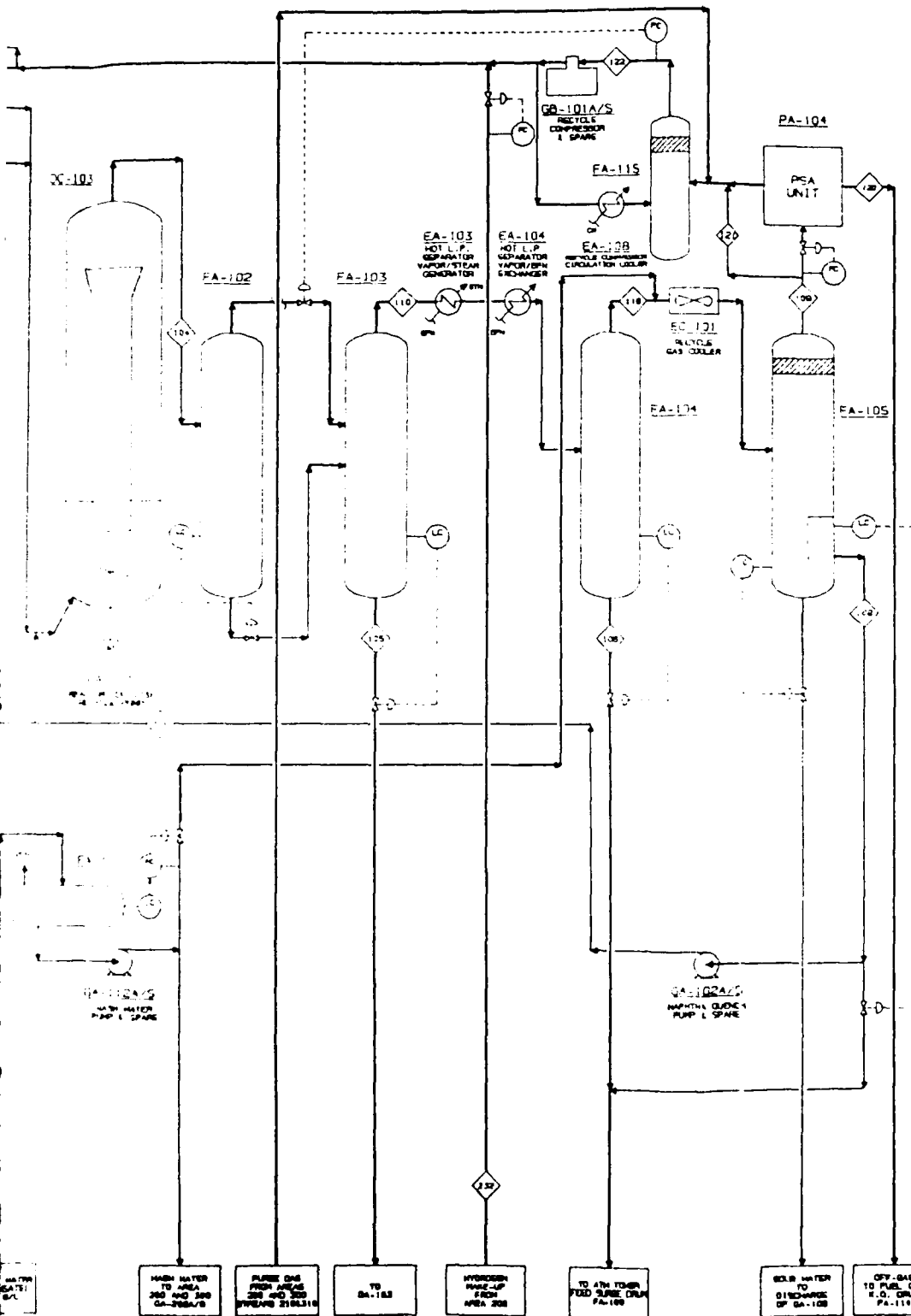
2.1 Tar Oil Stream - cont'd

2.1.4 Process Flow Diagrams

<u>Dwg.</u>	<u>Title</u>
E5571-101	Hydrotreater, Reaction Section
E5571-102	Hydrotreater, Fractionation Section
E5571-201	HDS, Reaction Section
E5571-202	HDS, Fractionation Section
E5571-301	Hydrocracker
SKB5571-103	PSA Unit (PA-104)
SKB5571-203	(PSA Unit PA-201)



DC-103 FA-111 FA-102 FA-103 FA-104 FA-115 FA-105 PA104
 G. HYDROTREATING REACTOR WASH WATER SURGE DRUM HOT H.P. SEPARATOR HOT L.P. SEPARATOR INTERM. L.P. RECYCLE COMPRESSOR K.O. DRUM COLD L.P. RECYCLE COMPRESSOR RECYCLE GAS PSA UNIT



PAGE 1 OF 1		DATE: 04/21/89	
PROJECT: 66571-101		DRAWN BY: J. L. HARRIS	
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CONSTRUCTION ENGINEERING		LUMBER GROUP, INC.	
PROCESS FLOW DIAGRAM HYDROTREATER, REACTION SECTION AREA 100			
SHEET NO. 1		E6671-101	

201-14953

GA-103
VACUUM TOWER

EA-106
HYGO
ACCUMULATOR

EA-107
LVGO
ACCUMULATOR

PA-101
VACUUM EJECTOR
PACKAGE

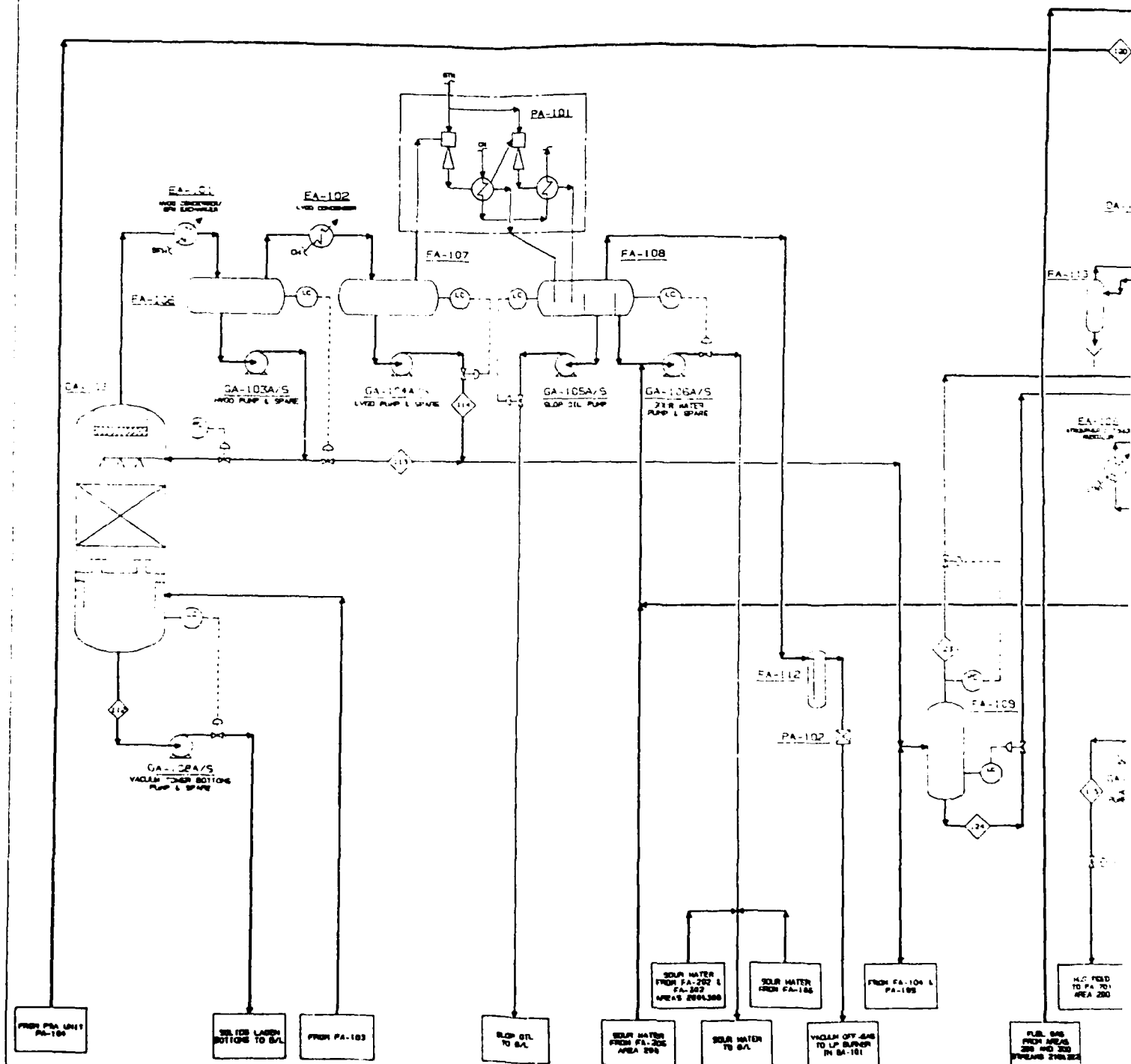
EA-108
VACUUM HOTWELL

FA-112
WATER
SEAL POT

PA-102
FLAME ARRESTOR
& SPARE

FA-109
ATM. TOWER
FEED SURGE
DRUM

FA-113
WATER
COLLECTION
POT



PA-102
FLAME ARRESTOR
& SPARE

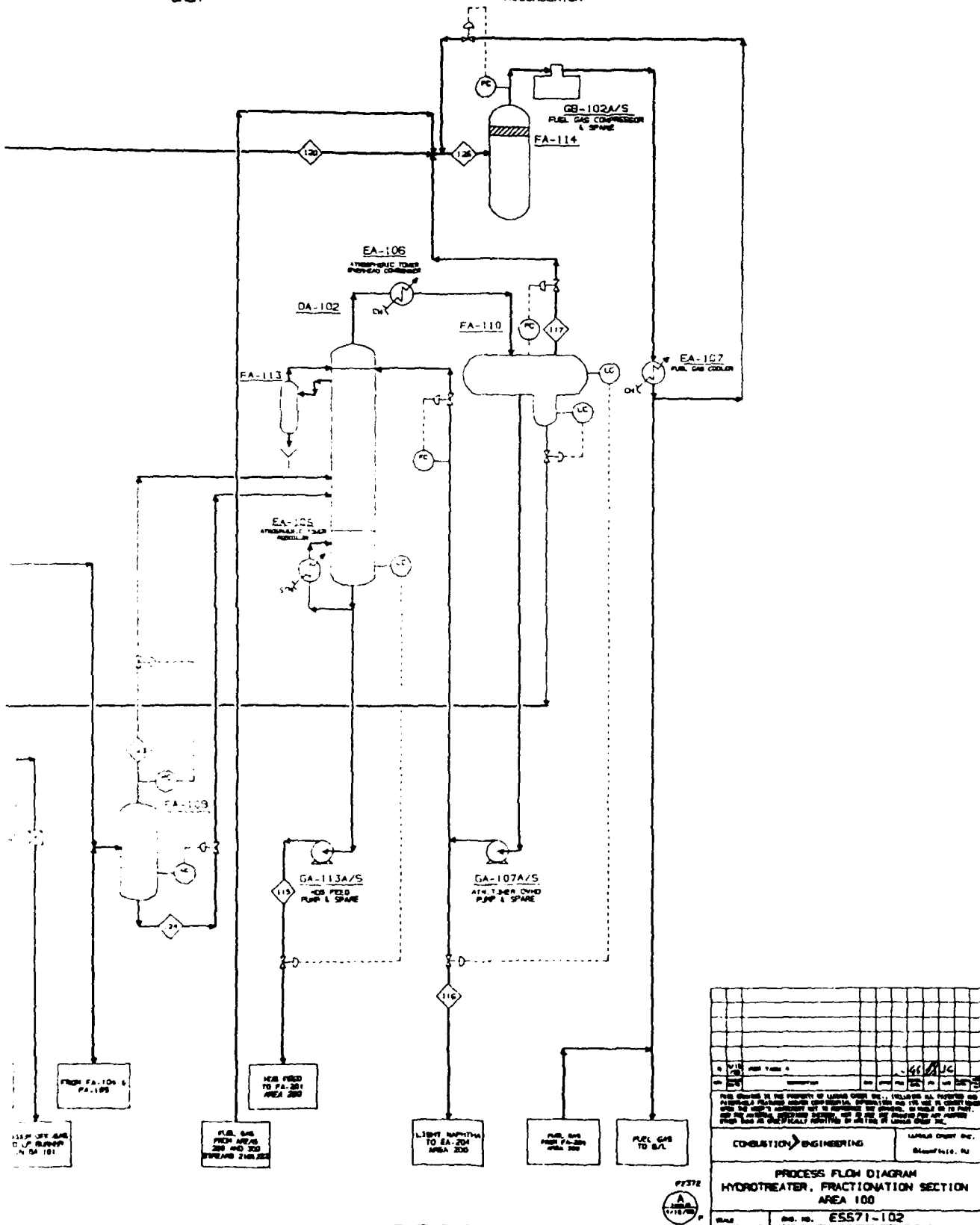
FA-109
ATM. TOWER
FEED SURGE
DRUM

FA-113
WATER
COLLECTION
POT

DA-102
ATMOSPHERIC
TOWER

FA-110
ATM. TOWER
OVERHEAD
ACCUMULATOR

FA-114
FUEL GAS
K.O. DRUM



REVISIONS	
NO.	DESCRIPTION
1	ISSUED FOR CONSTRUCTION
2	REVISED TO SHOW CHANGES
3	REVISED TO SHOW CHANGES
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<p>CONSLATION ENGINEERING LUMBER GROUP INC. Bloomfield, NJ</p>	
<p>PROCESS FLOW DIAGRAM HYDROTREATER, FRACTIONATION SECTION AREA 100</p>	
SCALE	DES. NO. ESS71-102

102-14553 OF 100

FA-201
HOS FEED
SURGE DRUM

FA-209
PSA TAIL GAS
K.O. DRUM

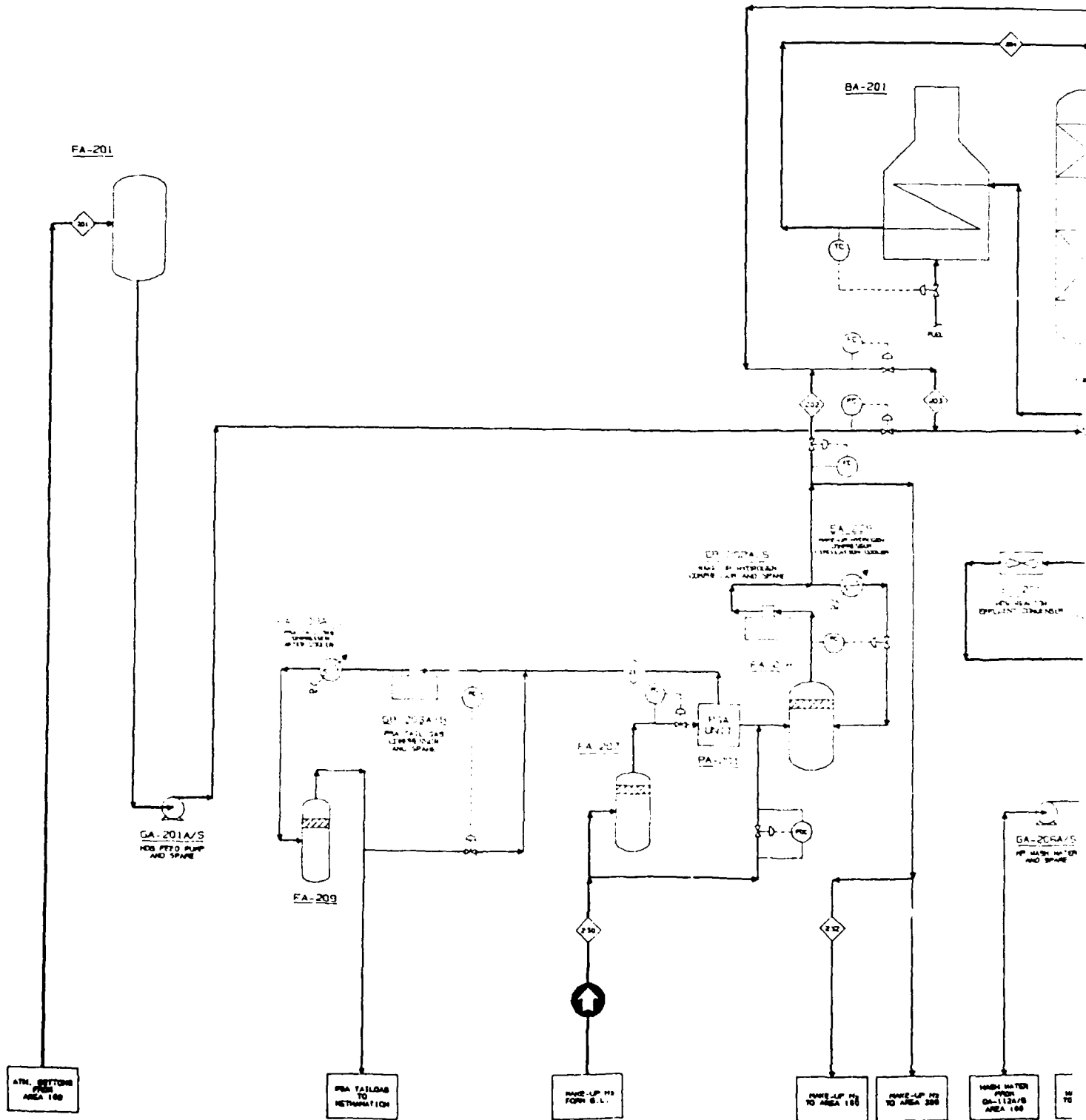
FA-207
PSA FEED GAS
K.O. DRUM

PA-201
MAKE-UP HYDROGEN
PSA UNIT

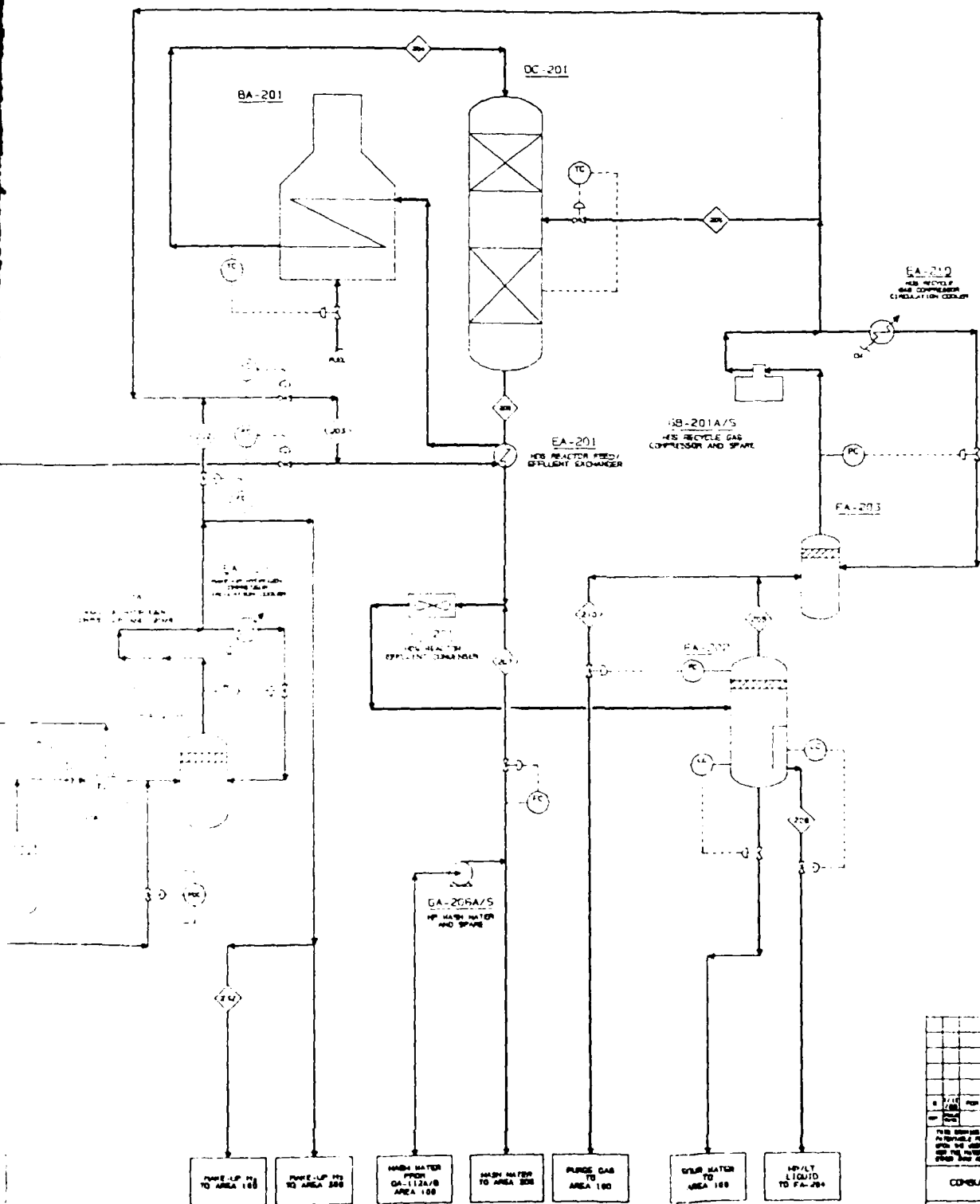
FA-208
MAKE-UP HYDROGEN
COMPRESSOR SUCTION
K.O. DRUM

BA-201
HOS FEED HEATER

DC-201
HOS REACTOR

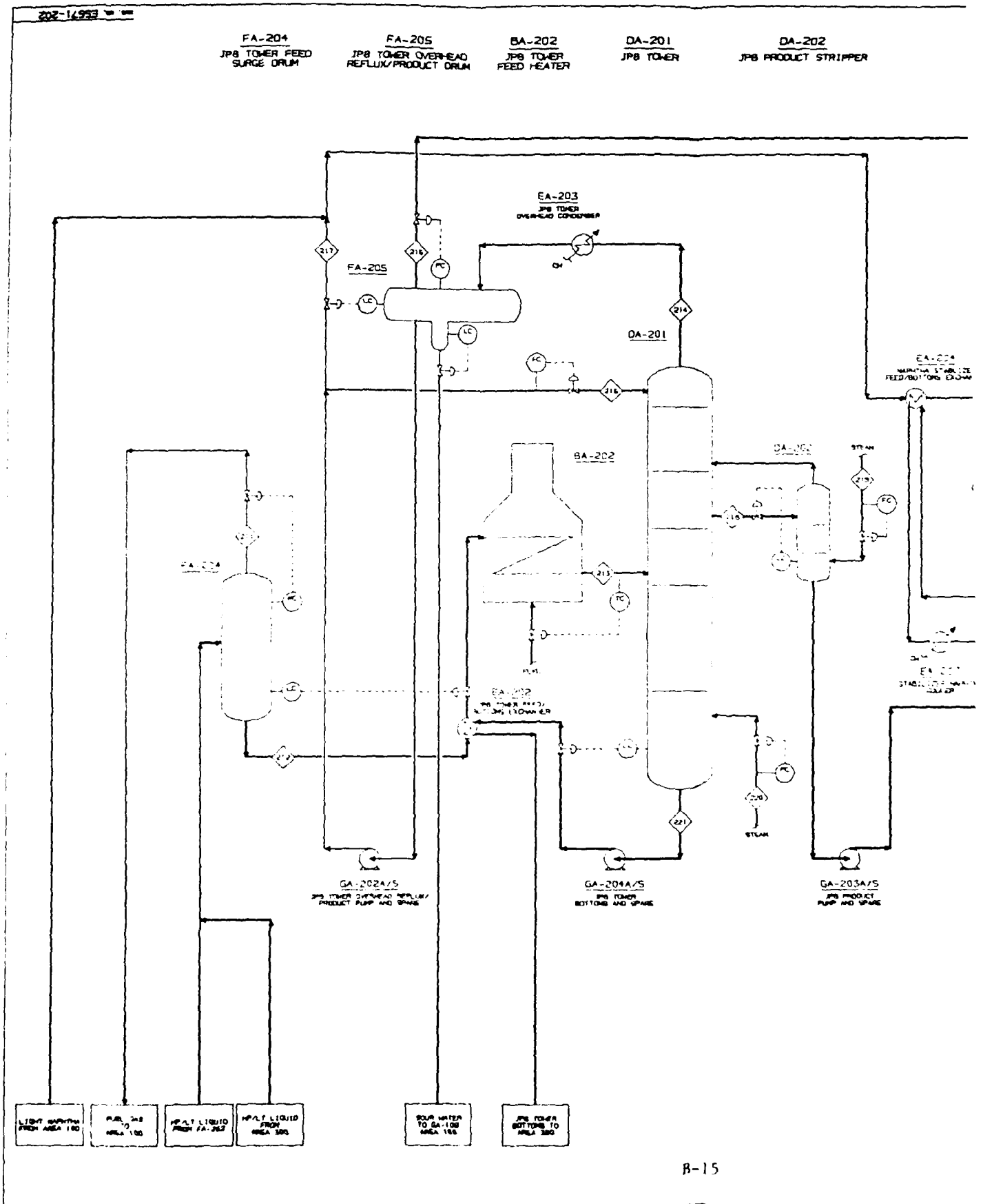


201 HYDROGEN UNIT
 FA-208 MAKE-UP HYDROGEN COMPRESSOR SUCTION K.O. DRUM
 BA-201 HOS FEED HEATER
 DC-201 HOS REACTOR
 FA-202 HOS REACTOR EFFLUENT HP/LT SEPARATOR
 FA-203 HOS RECYCLE GAS COMPRESSOR SUCTION K.O. DRUM



B-14

COMBUSTION ENGINEERING		LUNAR CORP. INC.	
PROCESS FLOW DIAGRAM		ESS71-201	
HOS, REACTION SECTION		AREA 200	
DATE		REV. NO.	
BY		CHECKED BY	
APPROVED BY		DATE	

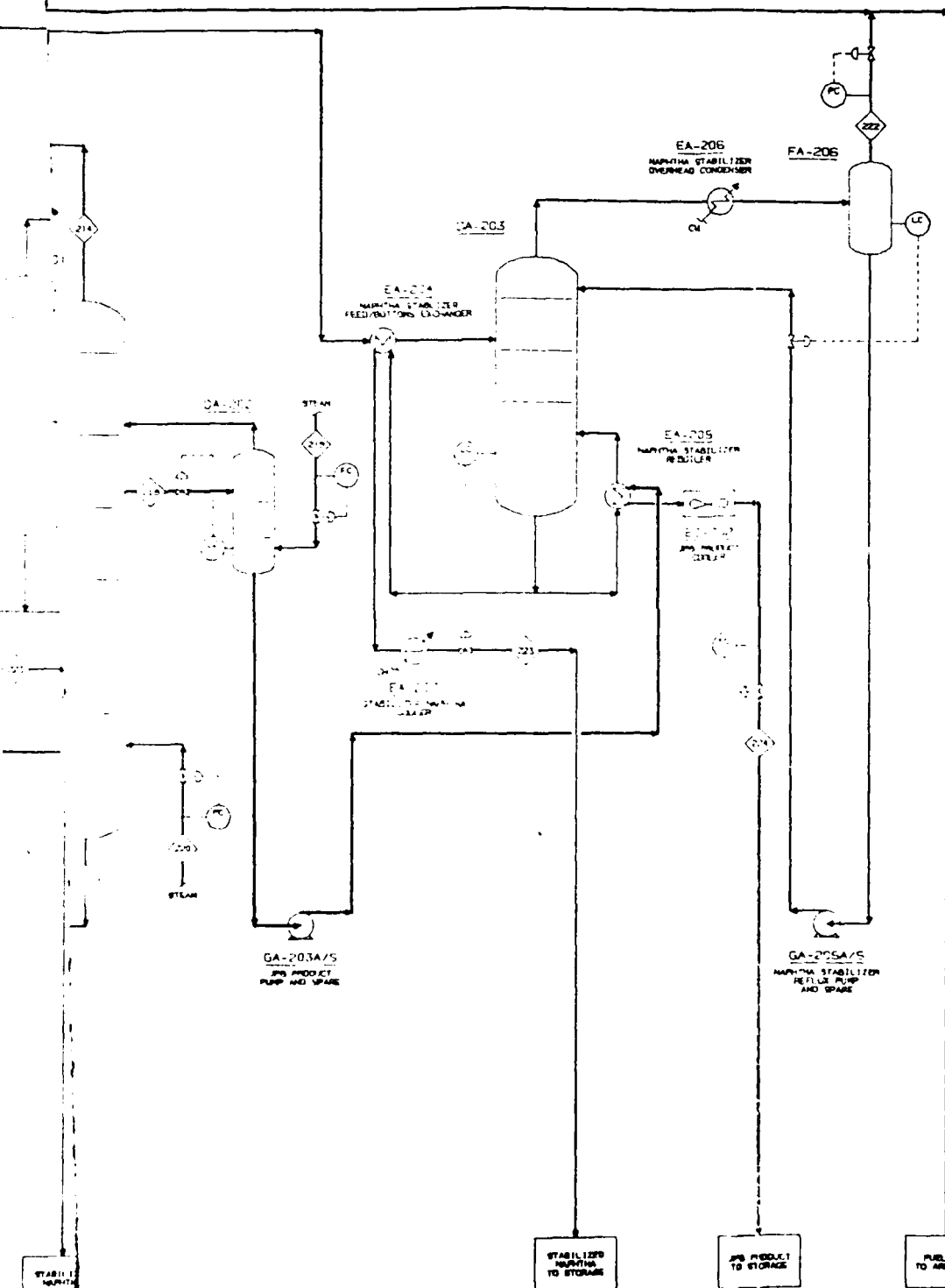


DA-201
NAPHTHA STABILIZER

DA-202
JPB PRODUCT STRIPPER

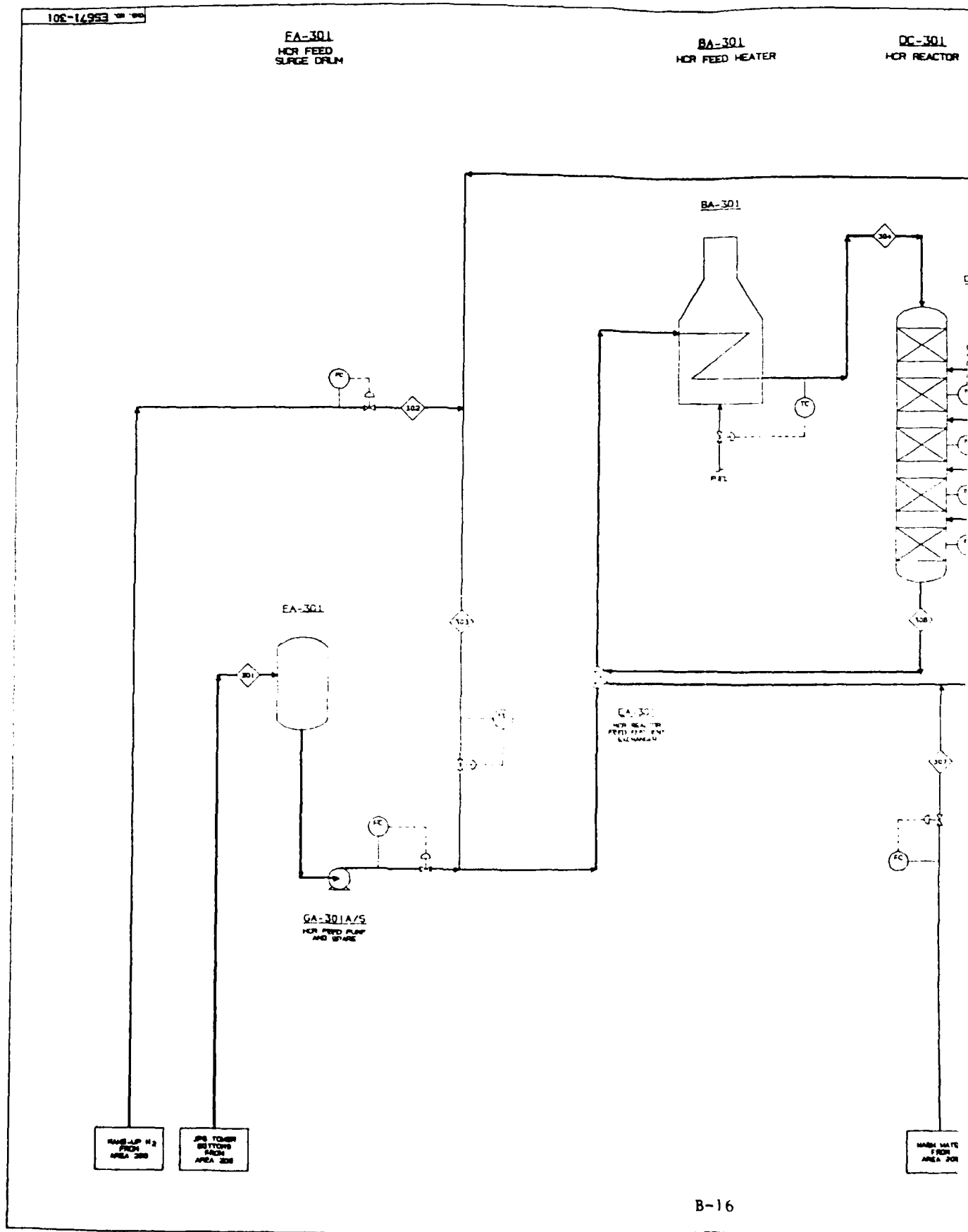
DA-203
NAPHTHA STABILIZER

FA-206
NAPHTHA STABILIZER OVERHEAD REFLUX DRUM



DATE		BY		CHECKED		APPROVED	
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COMBUSTION ENGINEERING				LAMAR CORP. INC.			
PROCESS FLOW DIAGRAM				STATION 1000, 101			
HDS. FRACTIONATION SECTION							
AREA 200							
P2375		REV. NO.		E5571-202		DATE	
11/11/80		1					

STABILIZED NAPHTHA TO STORAGE



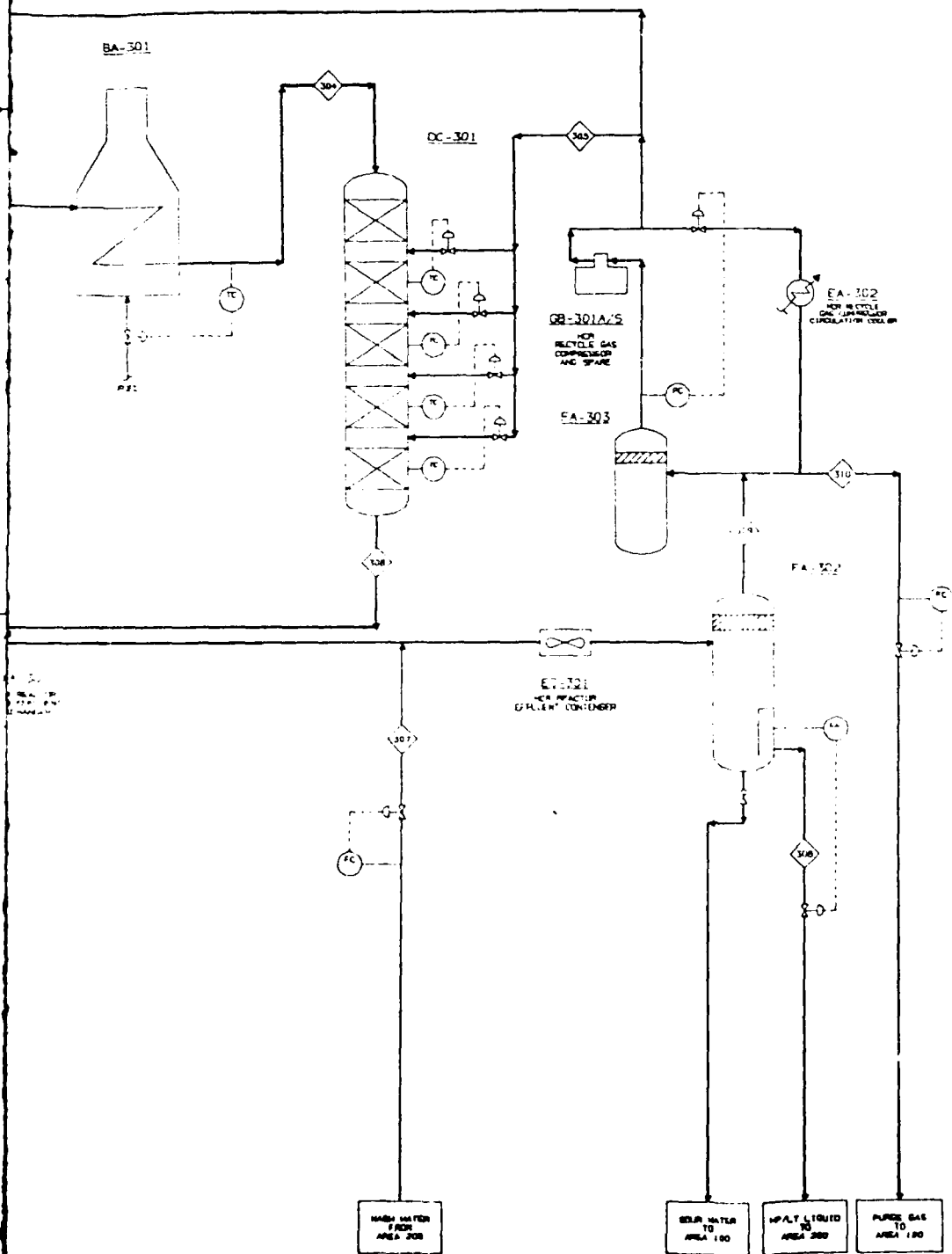
B-16

BA-301
HCR FEED HEATER

DC-301
HCR REACTOR

EA-303
HCR RECYCLE GAS
COMPRESSOR K.O. DRUM

EA-302
HCR REACTOR EFFLUENT
HP/LT SEPARATOR



DATE: 04/20/89		DRAWN: 1F2504 LOC	
PAPER: W		EXT: 1	
PROJECT: 11220 USER: D.RAP1 312		DATE: 04/20/89	
PROCESS FLOW DIAGRAM		HYDROCRACKER	
AREA 300		E5571-301	

B-16

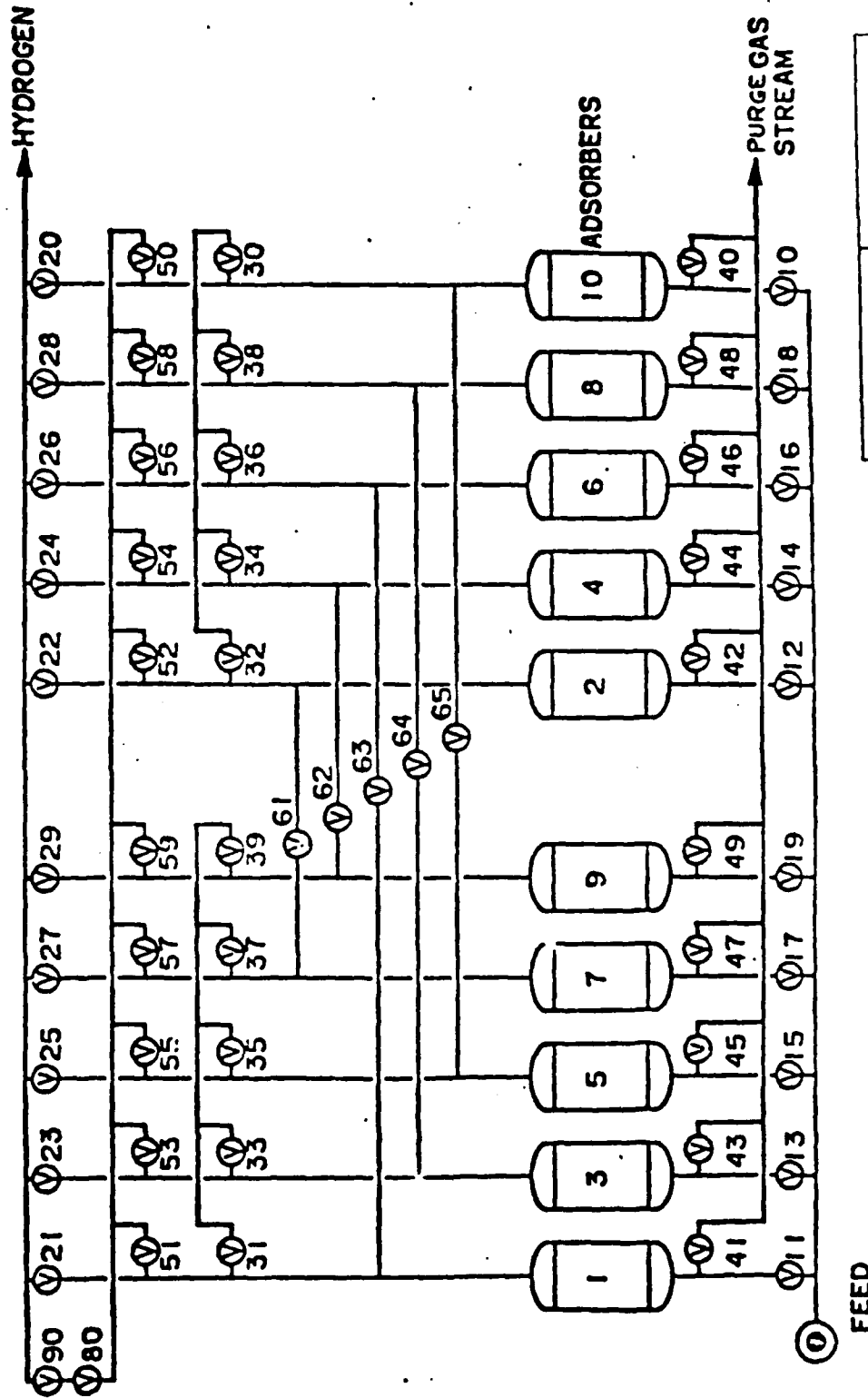
68/02/ DATE: 04/20/89

EXT: 1

DR: 1F2504 LOC

PL01:1220 USER: D.RAP1 312

SCHEMATIC FLOW SHEET - POLYBED PSA UNIT

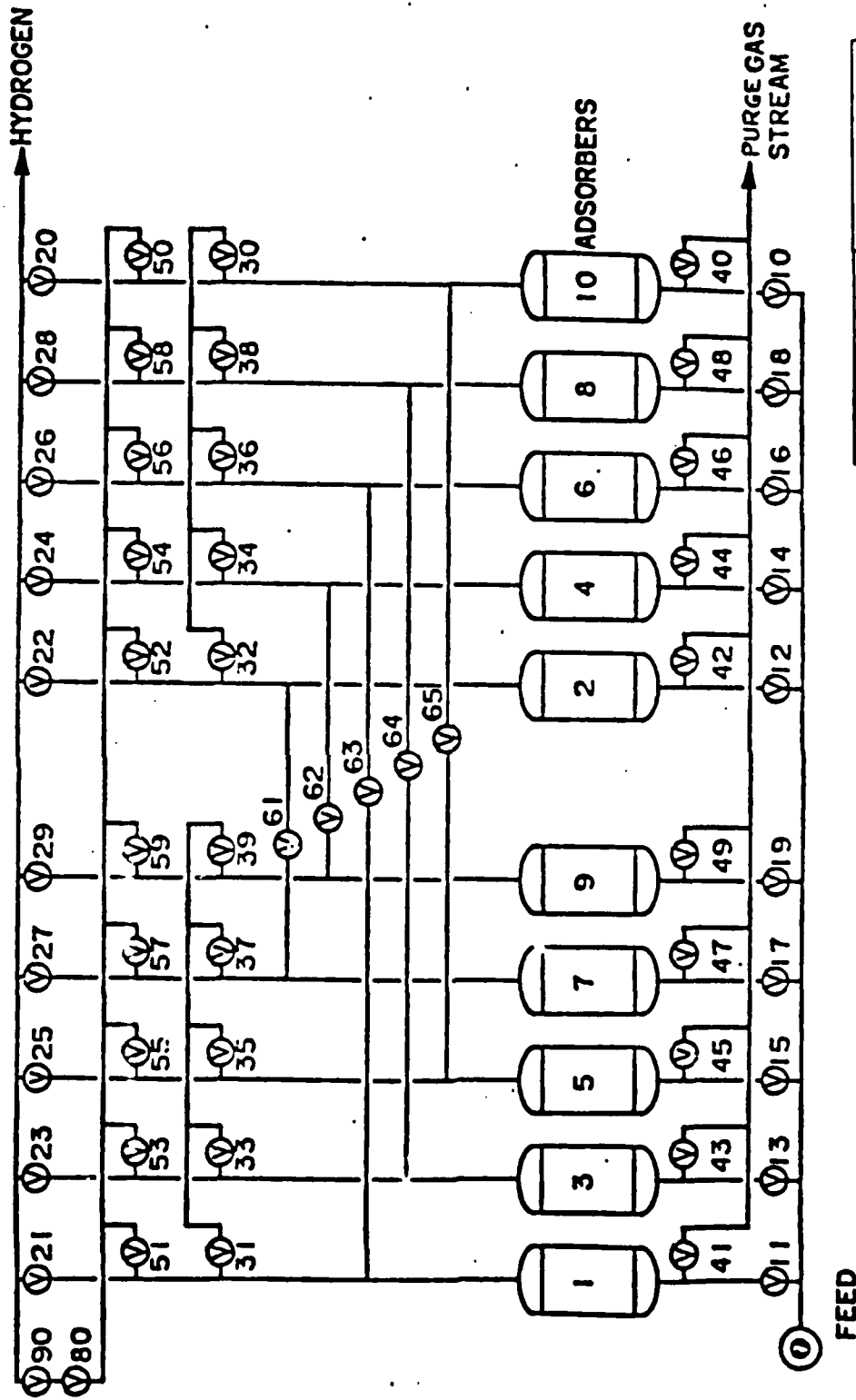


THE LUMBER COMPANY	
EE LUMBER	
TITLE PSA (HYDROGEN UNIT)	
CLIENT AMOCO/DOE JET FUEL STUDY	
PROJECT NO 5571	
AREA 100	
PROFITABLE JP-8 DESIGN	
DESIGNED BY	5571-03

TYPICAL ARRANGEMENT
NUMBER OF ADSORBERS: 4
ITEM NUMBER PA-104

FOR TASK 4	45	ES		
FOR TASK 1.2	ML	PS		
DESIGNED BY	5571-03	DESIGNED BY	5571-03	

SCHEMATIC FLOW SHEET - POLYBED PSA UNIT



THE LUMMUS COMPANY Birmingham	
PSA (HYDROGEN UNIT) CLIENT AMOCO/DOE JET FUEL STUDY PROJ NO 5571 AREA 200	
PROFITABLE JP-8 DESIGN	DATE 5571-003

TYPICAL ARRANGEMENT
NUMBER OF ADSORBERS: 10
ITEM NUMBER PA-201

REV	DATE	DESCRIPTION	PROJ	DATE	APP	DATE	APP
1	1/14/66	FOR TASK 4	ES				
2	1/14/66	FOR SURTASK 1.2	ML	ES			

LCI PROJECT 5571
TASK 4.0

2.1 Tar Oil Stream - cont'd

2.1.5 Material Balances

The following Material Balances were developed for Areas
100, 200 and 300.

DOE/AMOCO STUDY - 05571
 FEED/PRODUCT SUMMARY
 SECTIONS 100,200,300

FEEDS

TAR OIL

SOURCE	300 F+ COAL-DERIVED TAR OIL
GRAVITY	6.4 API
SULPHUR	4948 WPPM
NITROGEN	7291 WPPM
OXYGEN	548-6 WPPM
CARBON	84.71 WT%
HYDROGEN	8.60 WT%
BS&W	.5 WT%
DISTILLATION, ASTM D 2887	
0 VOL%	279 F
10	371 F
20	414 F
30	468 F
40	498 F
50	556 F
60	603 F
70	683 F
80	765 F
90	877 F
95	949 F
100	1018 F
FLOW RATE	45763 LB/M
TEMPERATURE AT B. L.	3060 BPSD
PRESSURE AT B. L.	128 F
	35 PSIG

HYDROGEN MAKE UP

SOURCE	FROM RECTISOL UNIT
COMPOSITION	
H2	63.19 MOL%
CO	18.61 MOL%
CO2	1.48 MOL%
C4+	16.21 MOL%
C2H6	0.13 MOL%
CO2, H2S, CS2	<0.01 MOL%
N2, Ar	0.19 MOL%
H2O	<0.01 MOL%
FLOW RATE	AS REQUIRED
TEMPERATURE	65 F
PRESSURE	355 PSIG

PRODUCTS

STABILISED NAPHTHA

GRAVITY	65.5 API
FLOW RATE	8512 LB/M
	813 BPSD
ESTIMATED RVP	10 PSI

JET FUEL (JPB)

GRAVITY	37.4 API
FLOW RATE	32500 LB/M
	2662 BPSD
ESTIMATED FLASH POINT	100 F
ESTIMATED POUR POINT	-70 F
DISTILLATION, ASTM D-86	
0 VOL%	298 F
5 VOL%	313 F
10 VOL%	323 F
30 VOL%	366 F
50 VOL%	408 F
70 VOL%	449 F
90 VOL%	492 F
95 VOL%	512 F
100 VOL%	547 F

JET FUEL PRODUCT
 J-0 5571
 MTL BAL - AHEAD
 100, 200, 300

DOE/AMOCO STUDY - 05571
 SECTIONS 100,200,300
 YIELD SUMMARY

LC-FINING YIELD						
	WT%	VOL%	API	SP.GR.	LB/H	BPSD
FEED						
1BP-550	49.50	51.89	12.78	0.98	22652.78	1584.92
550+	50.00	47.86	0.25	1.07	22881.60	1461.85
SOLIDS	0.50	0.26		2.00	228.82	7.85
	100.00	100.00	6.15	1.03	45763.20	3054.62
PRODUCTS						
H2S	0.49				224.24	
NH3	0.83				379.83	
H2O	5.74				2626.81	
C1	0.59				270.00	
C2	0.47				215.09	
C3	0.39				178.48	
C4	0.36	0.63		0.58	164.75	19.36
C5	0.94	1.53		0.63	430.17	46.76
C6-200	2.86	3.98	60.00	0.74	1308.83	121.54
200-550	59.16	71.57	35.00	0.85	27073.51	2185.99
550+	32.23	34.30	15.00	0.97	14749.48	1047.77
SOLIDS	0.48	0.25		2.00	219.66	7.54
	104.54	112.26			47840.85	3428.96
C4+	96.03	112.26	29.41	0.88	43946.40	3428.96
C5+	95.67	111.62	29.10	0.88	43781.65	3409.60
C6+	94.73	110.09	28.47	0.88	43351.48	3362.84
200+	91.87	106.11	27.49	0.89	42042.65	3241.30
CHEMICAL H2 CONSUMPTION :	3072.98 SCF/BBL					
CONVERSION (550+) :	35.54 WT%					

JE FUEL ST-01
 JUB 5771
 MTC FOR ALUM
 100 200,300

DOE/AMOCO STUDY-05571
DOE/AMOCO STUDY-05571
SECTION 100 - LC-FINING
MATERIAL BALANCE

STREAM ID	100	101	102	103	104.1	104.2	104	105	106
STREAM NAME	TAR OIL FEED	FRESH FEED	TOT.GAS TO 1ST RX	QUENCH GASES	RX EFFL. VAPOR	RX EFFL. LIQUID	REACTOR EFFLUENT	LP/MT LIQUID	LP/MT LIQUID
PHASE	LIQUID	LIQUID	VAPOR	VAPOR	VAPOR	LIQUID	MIXED	LIQUID	LIQUID
COMPOSITION, LBMOLS/H									
H2O			0.98	0.57	146.20	4.24	150.44	0.74	3.47
NH3					22.89	0.45	23.34	0.05	0.22
H2S					6.59	0.13	6.72	0.01	0.06
H2			1390.51	808.68	1156.39	13.63	1170.02	0.81	2.58
C1			4.47	2.60	23.70	0.33	24.03	0.03	0.09
C2			1.75	1.02	9.90	0.18	10.08	0.02	0.07
C3			0.84	0.49	5.57	0.12	5.69	0.02	0.06
C4			0.39	0.23	3.83	0.10	3.93	0.02	0.07
C5			0.41	0.24	7.78	0.24	8.02	0.05	0.21
150 F NBP			0.22	0.13	10.35	0.38	10.73	0.09	0.43
180 F NBP			0.12	0.07	9.34	0.37	9.71	0.09	0.47
212.5 F NBP			0.12	0.07	18.50	0.80	19.30	0.22	1.17
237.5 F NBP			0.08	0.04	19.19	0.89	20.08	0.27	1.46
262.5 F NBP			0.05	0.03	21.70	1.09	22.79	0.35	2.00
312.5 F NBP			0.04	0.02	62.92	3.76	66.68	1.41	8.60
387.5 F NBP					48.03	3.80	51.83	1.79	11.79
462.5 F NBP					35.70	3.83	39.53	2.20	14.90
512.5 F NBP					9.85	1.31	11.16	0.85	5.51
537.5 F NBP					7.79	1.16	8.95	0.79	4.92
600 F NBP					19.53	3.92	23.45	3.00	15.59
700 F NBP					11.56	3.85	15.41	3.35	11.09
800 F NBP					6.14	3.55	9.69	3.32	6.23
900 F NBP					2.85	3.02	5.87	2.94	2.92
1000 F NBP					0.02	0.05	0.07	0.05	0.02
LCF FEED		242.40				0.09		0.09	
TOTAL FLOW LBMOL/H	278.43	242.40	1399.98	814.19	1666.32	51.29	1717.52	22.56	93.93
LB/H	47670.00	45763.20	3095.80	1800.50	50559.40	7255.10	57814.50	5383.50	17880.20
TEMPERATURE, DEG.F	128.00	414.00	268.00	268.00	760.00	760.00	760.00	745.00	500.00
PRESSURE, PSIG	35.00	6.10	2245.00	2245.00	2210.00	2210.00	2210.00	385.00	330.00
MOLECULAR WEIGHT	171.21	188.79	2.21	2.21	30.34	141.45	33.66	238.63	190.36
GRAVITY, DEG. API	7.90	6.40				27.00		16.10	22.00
VAPOR FLOW, MMSCFD			12.75	7.42	15.18				
LIQUID FLOW, BPSD	3222.35	3060.17				557.62		385.31	1330.90
DENSITY AT P,T, LB/FT3	62.50	54.54	0.60	0.60	5.02	38.83		40.06	45.85
VISCOSITY AT P,T, CP	5.80	1.50	0.01	0.01	0.02	0.15		0.18	0.27
VAPOR COMPRESSIBILITY			1.07	1.07	1.03				
CONDUCTIVITY, BTU/H.F.FT	0.07	0.06	0.10	0.10	0.08	0.01		0.05	0.05
SURFACE TENSION, DYNE/CM	36.00	25.00						4.87	12.26
VAPOR FLOW AT P,T, ACFM			86.47	50.29	167.76				
LIQUID FLOW AT P,T, USGPM	95.19	104.72				23.32		16.77	48.67
ENTHALPY, MMBTU/H	-1.37	10.49	-0.78	-0.45	27.75	2.79	30.54	1.86	3.41

JET FUEL STUDY
JOB 5571
MATERIAL BALANCE
100 200, 300

DOE/AMOCO STUDY-05571
DOE/AMOCO STUDY-05571
SECTION 100 - LC-FINING
MATERIAL BALANCE

STREAM ID	108	109	110	111	112	113	114	115	116	117
STREAM NAME	LP/LT LIQUID	LP/LT VAPOR	LP/HT VAPOR	NAPHTHA QUENCH	VAC.TWR BOTTOMS	VAC.TWR DIST.#1	VAC.TWR DIST.#2	ATM.TWR BOTTOMS	LIGHT NAPHTHA	ATM.TWR O/H GAS
PHASE	LIQUID	VAPOR	VAPOR	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	VAPOR
COMPOSITION, LBMOLS/H										
H2O	11.53	5.16	149.69	2.97			0.07	0.02	6.70	5.62
NH3	4.03		23.29	1.04					0.27	2.95
H2S	0.72		6.70	0.18					0.03	0.56
H2	3.21	1163.42	1169.21	0.83						4.96
C1	0.35	23.57	24.01	0.09						0.35
C2	0.74	9.25	10.06	0.19					0.01	0.61
C3	1.17	4.45	5.68	0.30					0.06	0.87
C4	1.77	2.08	3.92	0.46					0.26	1.13
C5	5.58	2.18	7.98	1.44				0.02	1.71	2.64
150 F NBP	9.03	1.19	10.64	2.32			0.02	1.60	3.80	1.79
180 F NBP	8.52	0.62	9.62	2.19			0.04	5.09	1.41	0.38
212.5 F NBP	17.26	0.65	19.08	4.44			0.13	13.79	0.35	0.05
237.5 F NBP	17.96	0.40	19.82	4.62			0.19	14.99	0.06	0.01
262.5 F NBP	20.19	0.26	22.45	5.20			0.28	17.33	0.01	
312.5 F NBP	56.44	0.23	65.27	14.53		0.03	1.30	51.93		
387.5 F NBP	38.22	0.02	50.04	9.84		0.09	1.68	41.96		
462.5 F NBP	22.42		37.32	5.77	0.01	0.27	1.92	33.75		
512.5 F NBP	4.80		10.31	1.24		0.19	0.66	9.93		
537.5 F NBP	3.23		8.16	0.83		0.23	0.56	8.11		
600 F NBP	4.85		20.44	1.25	0.03	1.55	1.42	22.16		
700 F NBP	0.97		12.06	0.25	0.11	2.76	0.48	15.04		
800 F NBP	0.13		6.36	0.03	0.40	2.84	0.08	9.24		
900 F NBP	0.01		2.93		1.37	1.57	0.01	4.50		
1000 F NBP			0.02		0.04			0.03		
LCF FEED					0.09					
TOTAL FLOW LBMOL/H	233.13	1213.48	1695.06	60.01	2.05	9.53	8.84	249.49	14.67	21.92
LB/H	27802.00	3888.30	52430.90	7155.00	962.10	2821.80	1530.00	41496.80	744.70	684.00
TEMPERATURE, DEG.F	110.00	110.00	740.00	132.00	599.00	400.00	100.00	410.00	120.00	120.00
PRESSURE, PSIG	310.00	310.00	385.00	2310.00	13.00	85.00	13.00	27.30	150.00	20.30
MOLECULAR WEIGHT	119.26	3.20	30.93	119.23	469.32	296.10	173.08	166.33	50.76	31.20
GRAVITY, DEG. API	40.60		40.60	5.10	12.40	26.30	28.70	59.00		
VAPOR FLOW, MMSCFD		11.05	15.44							0.20
LIQUID FLOW, BPSD	2320.18		597.11	63.73	196.90	117.07	3223.61	68.79		
DENSITY AT P,T, LB/FT3	50.01	0.17	0.96	50.10	53.39	53.99	54.89	45.54	44.64	0.18
VISCOSITY AT P,T, CP	0.75	0.01	0.02	0.79	1.42	0.93	2.06	0.28	0.28	0.01
VAPOR COMPRESSIBILITY		1.01	1.00							0.98
CONDUCTIVITY, BTU/H.F.FT	0.07	0.07	0.08	0.07	0.04	0.05	0.07	0.05	0.09	0.01
SURFACE TENSION, DYNE/CM	24.84		23.59	18.60	23.27	30.79	14.11	21.57		
VAPOR FLOW AT P,T, ACFM		384.37	907.99							63.40
LIQUID FLOW AT P,T, USGPM	69.38		17.82	2.25	6.52	3.48	113.73	2.08		
ENTHALPY, MMBTU/H	0.07	-1.76	28.68	0.14	0.22	0.33	-0.02	5.96	0.06	0.23

JET FUEL ST-5
J03 5571
M-L BAL 2.500
100, 200, 300

DOE/AMOCO STUDY-05571
DOE/AMOCO STUDY-05571
SECTION 100 - LC-FINING
MATERIAL BALANCE

STREAM ID	118	120	121	122	123	124	125	126
STREAM NAME	LP/MT GASES	PSA TAIL GAS	PSA BY-PASS	TOT.GAS TO RX'S	ATM.TWR VAP.FEED	ATM.TWR LIQ.FEED	FUEL GASES	300F- TAR OIL
PHASE	VAPOR	VAPOR	VAPOR	VAPOR	VAPOR	LIQUID	VAPOR	LIQUID
COMPOSITION, LBMOLS/H								
H2O	146.22	3.61	1.55	1.55	0.16	12.18	10.43	
NH3	23.08				0.17	3.04	3.35	
H2S	6.65				0.04	0.55	0.65	
H2	1166.63	81.44	349.02	2199.18	1.97	3.00	92.92	
C1	23.92	16.50	7.07	7.07	0.07	0.28	23.44	
C2	9.99	6.47	2.77	2.77	0.05	0.57	12.89	
C3	5.62	3.12	1.34	1.33	0.04	0.89	10.29	
C4	3.85	1.46	0.62	0.62	0.03	1.35	11.38	
C5	7.77	1.53	0.66	0.65	0.05	4.32	6.22	
150 F NBP	10.22	0.83	0.36	0.36	0.04	7.15	3.87	
180 F NBP	9.15	0.44	0.19	0.19	0.03	6.85	1.51	
212.5 F NBP	17.91	0.46	0.20	0.20	0.04	14.15	0.78	
237.5 F NBP	18.36	0.28	0.12	0.12	0.03	15.03	0.47	
262.5 F NBP	20.44	0.18	0.08	0.08	0.02	17.32	0.24	
312.5 F NBP	56.67	0.16	0.07	0.07	0.04	51.89	0.16	
387.5 F NBP	38.25	0.02	0.01	0.01	0.01	41.95	0.02	
462.5 F NBP	22.42					33.75		
512.5 F NBP	4.80					9.93		
537.5 F NBP	3.23					8.11		
600 F NBP	4.85					22.16		
700 F NBP	0.97					15.04		
800 F NBP	0.13					9.24		
900 F NBP	0.01					4.50		
1000 F NBP						0.03		
LCF FEED								
TOTAL FLOW LBMOL/H	1601.14	112.89	362.51	2212.65	2.79	283.28	178.62	26.57
LB/H	34550.80	1244.20	1166.50	4896.30	43.40	42881.90	3398.20	1907.00
TEMPERATURE, DEG.F	500.00	110.00	105.00	105.00	301.00	301.00	107.00	120.00
PRESSURE, PSIG	330.00	1.30	305.00	280.00	185.00	185.00	1.20	50.00
MOLECULAR WEIGHT	21.58	11.02	3.22	2.21	15.56	151.38	19.02	71.77
GRAVITY, DEG. API						30.30		43.90
VAPOR FLOW, MMSCFD	14.58	1.03	3.30	20.15	0.03		1.63	
LIQUID FLOW, BPSD						3364.48		162.20
DENSITY AT P,T, LB/FT3	0.73	0.03	0.17	0.11	0.38	48.15	0.05	47.50
VISCOSITY AT P,T, CP	0.02	0.01	0.01	0.01	0.02	0.43	0.01	1.50
VAPOR COMPRESSIBILITY	1.00	1.00	1.01	1.01	0.99		1.00	
CONDUCTIVITY, BTU/H.F.FT	0.05	0.03	0.07	0.08	0.04	0.06	0.02	0.08
SURFACE TENSION, DYNE/CM						17.96		
VAPOR FLOW AT P,T, ACFM	792.41	741.39	117.05	765.53	1.89		1138.05	
LIQUID FLOW AT P,T, USGPM						111.15		5.01
ENTHALPY, MMBTU/H	14.29	0.08	-0.53	-3.91	0.01	3.76	0.57	0.21

JET FUEL STUDY
J63 5571
MTL BAL A 1000
100,200,300

DOE/AMOCO STUDY - 05571
 SECTIONS 100,200,300
 YIELD SUMMARY

HYDROTREATING YIELD.....						
	WT%	VOL%	API	SP.GR.	LB/H	BPSD
FEED						
1BP-550	64.50	67.38	35.01	0.85	26765.44	2161.12
550+	35.50	32.63	15.00	0.97	14731.36	1046.48
SOLIDS	0.00					
	100.00	100.00	27.90	0.89	41496.80	3207.60
PRODUCTS						
H2S	0.01				4.15	
NH3	0.02				8.30	
H2O	0.11				45.65	
C1	0.61				253.13	
C2	0.44				182.59	
C3	0.35				145.24	
C4	0.15	0.23		0.58	62.25	7.31
C5	1.09	1.53		0.63	452.32	49.17
C6-200	2.50	3.00	60.00	0.74	1037.42	96.34
200-550	65.83	69.58	37.00	0.84	27317.34	2231.95
550+	29.93	28.46	20.10	0.93	12419.99	913.01
SOLIDS						
	101.04	102.81			41928.37	3297.77
C4+	99.50	102.81	33.21	0.86	41289.32	3297.77
C5+	99.35	102.59	33.09	0.86	41227.07	3290.46
C6+	98.26	101.05	32.43	0.86	40774.76	3241.29
200+	95.76	98.05	31.71	0.87	39737.34	3144.96
CHEMICAL H2 CONSUMPTION :	607.87	SCF/BB.				
CONVERSION (550+) :	15.69	WT%				

JET FUEL STUDY
 JOB 5571
 MTL BML ALEAS
 100,200,300

DOE/AMOCO STUDY-05571
SECTION 200 - MDS/JP8 DISTILLATION
MATERIAL BALANCE

STREAM ID	201	202	203	204	205	206.1	206.2	206	207	208
STREAM NAME	FRESH FEED	MAKE-UP HYDROGEN	TOT. GAS TO RX	REACTOR FEED	HYDROGEN QUENCH	RX EFFL. VAPOR	RX EFFL. LIQUID	REACTOR EFFLUENT	WASH WATER	HP/LT LIQUID
PHASE	LIQUID	VAPOR	VAPOR	MIXED	VAPOR	VAPOR	LIQUID	MIXED	LIQUID	LIQUID
COMPOSITION, LBMOLS/H										
N2										
CO										
CO2										
H2O			0.51	0.51	0.21	2.95	0.30	3.25	66.61	0.97
NH3			0.13	0.13	0.05	0.61	0.06	0.67		0.45
H2S			0.06	0.06	0.02	0.18	0.02	0.20		0.11
H2		306.73	611.02	611.02	244.98	601.18	39.33	640.51		30.19
C1			32.92	32.92	13.20	57.51	4.39	61.90		10.51
C2			3.94	3.94	1.58	10.59	1.00	11.59		5.37
C3			0.82	0.82	0.33	4.01	0.44	4.45		3.13
C4			0.10	0.10	0.04	1.07	0.14	1.21		1.05
C5			0.23	0.23	0.09	5.74	0.85	6.59		6.21
150 F NBP			0.08	0.08	0.03	4.44	0.76	5.20		5.09
180 F NBP			0.06	0.06	0.03	5.95	1.09	7.04		6.94
212.5 F NBP			0.03	0.03	0.01	5.31	1.05	6.36		6.31
237.5 F NBP			0.03	0.03	0.01	8.10	1.70	9.80		9.75
262.5 F NBP			0.02	0.02	0.01	8.96	2.02	10.98		10.94
312.5 F NBP			0.03	0.03	0.01	26.86	6.98	33.84		33.80
387.5 F NBP			0.01	0.01		30.55	10.11	40.66		40.65
462.5 F NBP						30.02	12.95	42.97		42.97
512.5 F NBP						9.02	4.71	13.73		13.73
537.5 F NBP						10.68	6.15	16.83		16.83
600 F NBP						11.70	8.73	20.43		20.43
700 F NBP						5.59	6.49	12.08		12.07
800 F NBP						2.18	4.08	6.26		6.26
900 F NBP						0.94	3.00	3.94		3.95
MDS FEED	249.49			249.49						
TOTAL FLOW, LBMOL/H	249.49	306.73	649.99	899.48	260.60	844.14	116.35	960.49	66.61	287.71
LB/H	41496.80	618.40	1976.60	43473.40	792.50	29567.50	14696.20	44265.90	1200.00	41837.20
TEMPERATURE, DEG. F	410.00	100.00	108.00	740.00	109.00	760.00	760.00	760.00	120.00	120.00
PRESSURE, PSIG	35.00	2535.00	2469.00	2405.00	2530.00	2385.00	2385.00	2385.00	2354.00	2335.00
MOLECULAR WEIGHT	166.33	2.02	3.04	48.33	3.04	35.03	126.31	46.09	18.02	145.41
GRAVITY, DEG. API	28.70						40.50			38.40
VAPOR FLOW, MMSCFD		2.79	5.92		2.37	7.69				
LIQUID FLOW, BPSD	3223.61						1225.74		76.52	3446.84
DENSITY AT P,T, LB/FT3	45.53	0.79	1.15		1.12	6.11	42.18		61.71	51.42
VISCOSITY AT P,T, CP	0.28	0.01	0.01		0.01	0.03	0.14		0.56	1.35
VAPOR COMPRESSIBILITY		1.08	1.08		1.08	1.05				
CONDUCTIVITY, BTU/H.F.FT	0.05	0.09	0.08		0.08	0.01	0.11		0.37	0.07
SURFACE TENSION, DYNE/CM	14.11						43.44		68.25	22.53
VAPOR FLOW AT P,T, ACFM		13.00	28.68		11.82	80.60				
LIQUID FLOW AT P,T, USGPM	113.74						43.49		2.43	101.54
ENTHALPY, MMBTU/H	5.96	-0.57	-1.03	18.87	-0.41	15.01	6.08	21.09	0.11	0.45

JET FUEL STUDY
JOB 5571
MTL 3M AREA
140, 200, 300
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DOE/AMOCO STUDY-05571
SECTION 200 - NDS/JP8 DISTILLA
MATERIAL BALANCE

STREAM ID	209	210	211	212	213.1	213.2	213	214	215	216
STREAM NAME	HP/LT VAPOR	PURGE GASES	LP/LT VAP TO FUEL	JP8 TWR FEED	JP8 HTR VAPOR	JP8 HTR LIQUID	JP8 HTR OUTLET	JP8 TWR O/H GAS	JP8 TWR REFLUX	JP8 TWR NET C.
PHASE	VAPOR	VAPOR	VAPOR	LIQUID	VAPOR	LIQUID	MIXED	VAPOR	LIQUID	VAPOR
COMPOSITION, LBMOLS/H										
N2										
CO										
CO2										
H2O	0.81	0.08	0.22	1.03	1.03	0.00	1.03	82.74	1.12	1.19
NH3	0.21	0.02	0.05	0.40	0.40	0.00	0.40	0.40		0.40
H2S	0.09	0.01	0.02	0.09	0.09	0.00	0.09	0.09		0.09
H2	610.31	61.03	39.05	6.52	6.52	0.00	6.52	6.99	0.47	6.47
C1	51.39	5.14	8.65	6.59	6.59	0.00	6.59	7.99	1.40	6.44
C2	6.21	0.62	1.60	5.80	5.80	0.00	5.80	11.89	6.09	5.15
C3	1.32	0.13	0.66	8.40	8.38	0.02	8.40	11.08	4.68	5.90
C4	0.16	0.02	0.46	19.82	19.80	0.02	19.82	128.72	108.90	8.19
C5	0.38	0.04	0.11	10.79	10.78	0.01	10.79	93.38	82.59	1.97
150 F NBP	0.12	0.01	0.06	17.32	17.32	0.05	17.32	167.58	150.28	1.25
180 F NBP	0.10	0.01	0.04	17.00	17.00	0.04	17.00	169.10	152.16	0.69
212.5 F NBP	0.05	0.01	0.02	13.15	13.11	0.04	13.15	131.57	118.63	0.27
237.5 F NBP	0.05	0.01	0.01	16.14	16.09	0.05	16.14	150.45	135.77	0.18
262.5 F NBP	0.04			16.93	16.85	0.08	16.93	84.31	76.12	0.06
312.5 F NBP	0.04			53.21	52.85	0.36	53.21	2.49	2.25	
387.5 F NBP	0.01			59.10	58.42	0.68	59.10	1.04	0.94	
462.5 F NBP				64.26	62.93	1.33	64.26			
512.5 F NBP				19.73	19.11	0.62	19.73			
537.5 F NBP				19.66	18.91	0.75	19.66			
600 F NBP				30.03	28.11	1.92	30.03			
700 F NBP				17.20	14.46	2.74	17.20			
800 F NBP				9.79	6.34	3.45	9.79			
900 F NBP				5.78	2.05	3.73	5.78			
NDS FEED						0.00	0.00			
TOTAL FLOW, LBMOL/H	671.29	67.13	50.95	418.74	402.85	15.89	418.74	1049.82	841.40	38.25
LB/H	2399.60	240.00	346.50	64546.00	59556.30	4989.70	64546.00	85484.70	74690.40	1389.20
TEMPERATURE, DEG. F	120.00	120.00	120.00	120.00	650.00	650.00	650.00	248.00	100.00	100.00
PRESSURE, PSIG	2335.00	2335.00	335.00	335.00	35.00	35.00	35.00	15.30	15.30	15.30
MOLECULAR WEIGHT	3.57	3.58	6.80	154.14	147.84	314.02	154.14	81.43	88.77	36.32
GRAVITY, DEG. API				38.60		26.30			67.50	
VAPOR FLOW, MMSCFD	6.11	0.61	0.46		3.67			9.56		0.35
LIQUID FLOW, BPSD				5324.00		381.81			7207.47	
DENSITY AT P,T, LB/FT3	1.25	1.25	0.38	50.53	0.66	43.49		1.32	43.06	0.19
VISCOSITY AT P,T, CP	0.01	0.01	0.01	1.12	0.01	0.27		0.02	0.31	0.01
VAPOR COMPRESSIBILITY	1.08	1.08	1.00		0.94			0.99		0.98
CONDUCTIVITY, BTU/H.F.FT	0.07	0.07	0.07	0.07	0.03	0.04		0.03	0.07	0.01
SURFACE TENSION, DYNE/CM				24.18		14.45				
VAPOR FLOW AT P,T, ACFM	32.05	3.21	15.16		1503.95			1078.54		123.81
LIQUID FLOW AT P,T, USGPM				159.42		14.32			216.45	
ENTHALPY, MMBTU/H	-0.92	-0.09	-0.03	0.43	24.77	1.58	26.34	16.83	0.50	0.25

JET FUEL STUDY
JUG 5571
NGL BAL AREAS
100, 200, 300

DOE/AMOCO STUDY-05571
SECTION 200 - NDS/JPB DISTILLA
MATERIAL BALANCE

STREAM ID	217	218	219	220	221	222	223	224	230	231
STREAM NAME	JPB TWR O/H LIQ	JPB STRP. FEED	JPB STRP. S.STEAM	JPB TWR S.STEAM	JPB TWR BOTTOMS	STABILIS. O/H GAS	STABIL'D NAPHTHA	JPB PRODUCT	MAKEUP H2 PSA FEED	PSA TAIL GAS
PHASE	LIQUID	LIQUID	VAPOR	VAPOR	LIQUID	VAPOR	LIQUID	LIQUID	VAPOR	VAPOR
COMPOSITION, LBMOLS/H										
N2									5.97	5.97
CO									585.01	585.01
CO2									46.52	46.52
H2O	0.12	0.18	51.71	30.00	0.83	0.01			0.32	0.32
NH3										
H2S										
H2	0.03	0.01				0.05			1986.38	278.09
C1	0.15	0.02				0.15			509.56	509.56
C2	0.65	0.04				0.66			9.74	9.74
C3	2.50	0.09				0.40	0.16			
C4	11.63	0.40				0.60	11.29			
C5	8.83	0.39				0.08	10.45			
150 F NBP	16.04	1.14					19.85	0.02		
180 F NBP	16.26	1.64					17.66	0.06		
212.5 F NBP	12.68	2.51					13.02	0.21		
237.5 F NBP	14.53	9.17					14.56	1.46		
262.5 F NBP	8.12	31.85			0.01		8.14	8.73		
312.5 F NBP	0.27	95.67			0.08		0.24	52.89		
387.5 F NBP		70.75			0.66		0.10	58.34		
462.5 F NBP		62.96			5.45			58.82		
512.5 F NBP		13.78			6.40			13.32		
537.5 F NBP		8.87			11.00			8.66		
600 F NBP		2.62			27.58			2.57		
700 F NBP		0.01			17.19					
800 F NBP					9.79					
900 F NBP					5.78					
NDS FEED										
TOTAL FLOW, LBMOL/H	91.81	302.10	51.71	30.00	84.77	1.95	95.47	205.08	3143.50	1435.22
LB/H	7981.30	44763.20	931.60	540.50	22680.00	80.80	8512.40	32500.00	31077.00	27634.89
TEMPERATURE, DEG.F	100.00	394.00	650.00	650.00	562.00	100.00	100.00	120.00	65.00	75.00
PRESSURE, PSIG	135.00	21.80	85.00	85.00	23.50	110.00	50.00	50.00	355.00	5.00
MOLECULAR WEIGHT	86.93	148.17	18.02	18.02	267.55	41.44	89.16	158.47	9.89	19.25
GRAVITY, DEG. API	67.50	40.10			22.90		65.50	37.40		
VAPOR FLOW, MMSCFD						0.02			28.63	13.07
LIQUID FLOW, BPSD	770.18	3724.80			1698.07		813.17	2661.81		
DENSITY AT P,T, LB/FT3	43.06	42.00	0.15	0.15	45.54	0.85	43.24	51.15	0.65	0.07
VISCOSITY AT P,T, CP	0.31	0.22	0.02	0.02	0.30	0.01	0.33	0.45		
VAPOR COMPRESSIBILITY						0.98			1.00	1.00
CONDUCTIVITY, BTU/H.F.FT	0.07	0.05	0.03	0.03	0.04	0.01	0.07	0.07		
SURFACE TENSION, DYNE/CM	18.49	12.23			13.49		18.20			
VAPOR FLOW AT P,T, ACFM			101.48	58.88		1.59			796.92	6859.38
LIQUID FLOW AT P,T, USGPH	23.13	133.01			62.16		24.57	79.30		
ENTHALPY, MMBTU/H	0.05	6.90	1.26	0.73	5.61	0.01	0.06	0.11		

JET FUEL STUDY
JOB 5571
MTC BAL AREA
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DOE/AMOCO STUDY-05571
SECTION 200 - HDS/JPB DISTILLA
MATERIAL BALANCE

STREAM ID	232
STREAM NAME	MAKEUP H2 TO LCF
PHASE	VAPOR
COMPOSITION, LBMOLS/H	
N2	
CO	
CO2	
H2O	
NH3	
H2S	
H2	1117.22
C1	
C2	
C3	
C4	
C5	
150 F NBP	
180 F NBP	
212.5 F NBP	
237.5 F NBP	
262.5 F NBP	
312.5 F NBP	
387.5 F NBP	
462.5 F NBP	
512.5 F NBP	
537.5 F NBP	
600 F NBP	
700 F NBP	
800 F NBP	
900 F NBP	
HDS FEED	
TOTAL FLOW, LBMOL/H	1117.22
LB/H	2251.19
TEMPERATURE, DEG.F	65.00
PRESSURE, PSIG	2505.00
MOLECULAR WEIGHT	2.02
GRAVITY, DEG. API	
VAPOR FLOW, MMSCFD	10.18
LIQUID FLOW, BPSD	
DENSITY AT P,T, LB/FT3	0.97
VISCOSITY AT P,T, CP	
VAPOR COMPRESSIBILITY	1.08
CONDUCTIVITY, BTU/H.F.FT	
SURFACE TENSION, DYNE/CM	
VAPOR FLOW AT P,T, ACFM	38.50
LIQUID FLOW AT P,T, USGPM	
ENTHALPY, MMBTU/H	

JET FUEL STUDY
JOB 5571
VT- BAL AREA
100.240.300

DOE/AMOCO STUDY - 05571
SECTIONS 100, 200, 300
YIELD SUMMARY

HYDROCRACKING YIELD-----						
	WT%	VOL%	API	SP. GR.	LB/H	BPSD
FEED						
180-550						
550+	100.00	100.00	22.89	0.92	22680.00	1697.98
SOLIDS						
	100.00	100.00	22.89	0.92	22680.00	1697.98
PRODUCTS						
H2S	0.00				0.00	
H2	0.00				0.00	
H2O	0.02				4.54	
C1	0.50				113.40	
C2	0.30				68.04	
C3	1.20				272.16	
C4	5.00	7.85		0.58	1134.00	133.24
C5	1.50	2.18		0.63	340.20	36.98
C6-200	8.50	10.98	68.00	0.71	1927.80	186.49
200-515	57.50	63.87	40.00	0.83	13041.00	1084.49
515+	27.34	27.71	25.00	0.90	6200.71	470.54
SOLIDS						
	101.86	112.59			23101.85	1911.74
C4+	99.84	112.59	42.61	0.81	22643.71	1911.74
C5+	94.84	104.74	39.01	0.83	21509.71	1778.50
C6+	93.34	102.56	38.15	0.83	21169.51	1741.52
200+	84.84	91.58	35.16	0.85	19241.71	1555.03
CHEMICAL H2 CONSUMPTION : 1122.42 SCF/BBL						
CONVERSION (315) : 72.66 WT%						

JET FUEL STUDY
JOB 5571
MTL BAL AREA
100, 200, 300

DOE/AMOCO STUDY-05571
SECTION 300 - HYDROCRACKING
MATERIAL BALANCE
DOE/AMOCO STUDY-05571
SECTION 300 - HYDROCRACKING
MATERIAL BALANCE

STREAM ID	301	302	303	304	305	306.1	306.2	306	307	308
STREAM NAME	FRESH FEED	MAKE-UP HYDROGEN	TOT. GAS TO RX	REACTOR FEED	HYDROGEN QUENCH	RX EFFL. VAPOR	RX EFFL. LIQUID	REACTOR EFFLUENT	WASH WATER	HP/LT LIQUID
PHASE	LIQUID	VAPOR	VAPOR	MIXED	VAPOR	VAPOR	LIQUID	MIXED	LIQUID	LIQUID
COMPOSITION, LBMOLS/H										
N2O			0.92	0.92	0.85	2.02		2.02	0.05	0.28
NH3										
N2S										
N2		253.53	1192.49	1192.49	1106.27	2091.16	0.60	2091.76		15.38
C1			78.42	78.42	72.75	158.18	0.06	158.25		4.73
C2			7.86	7.86	7.29	17.40	0.01	17.41		2.03
C3			8.18	8.18	7.59	21.92	0.02	21.93		5.93
C4			9.47	9.47	8.78	37.72	0.04	37.76		19.23
C5			0.88	0.88	0.81	6.40	0.01	6.40		4.69
150 F NBP			0.92	0.92	0.86	14.07	0.02	14.10		12.29
180 F NBP			0.45	0.45	0.42	10.96	0.02	10.98		10.10
212.5 F NBP			0.17	0.17	0.16	7.19	0.01	7.20		6.86
237.5 F NBP			0.10	0.10	0.09	6.58	0.02	6.59		6.40
262.5 F NBP			0.06	0.06	0.05	6.09	0.02	6.11		5.99
312.5 F NBP			0.07	0.07	0.06	19.48	0.07	19.55		19.41
387.5 F NBP			0.01	0.01	0.01	18.38	0.10	18.48		18.45
462.5 F NBP						21.12	0.18	21.30		21.29
512.5 F NBP						5.93	0.07	6.00		6.00
537.5 F NBP						2.79	0.04	2.83		2.83
600 F NBP						9.38	0.21	9.60		9.60
700 F NBP						4.88	0.25	5.13		5.13
800 F NBP						3.14	0.39	3.53		3.53
900 F NBP						1.37	0.46	1.83		1.83
HCR FEED	84.77			84.77						
TOTAL FLOW, LBMOL/H	84.77	253.53	1300.00	1384.77	1205.99	2466.16	2.60	2468.76	0.05	181.98
LB/H	22680.00	511.10	5051.80	27731.80	4686.60	31835.80	587.30	32418.40	0.90	23055.30
TEMPERATURE, DEG. F	300.00	100.00	118.00	650.00	118.00	670.00	670.00	670.00	120.00	120.00
PRESSURE, PSIG	35.00	1835.00	1835.00	1715.00	1835.00	1685.00	1685.00	1685.00	1686.00	1635.00
MOLECULAR WEIGHT	267.55	2.02	3.89	20.03	3.89	12.91	225.88	13.13	18.00	126.69
GRAVITY, DEG. API	22.90						30.75			47.80
VAPOR FLOW, MMSCFD		2.31	11.84		10.98	22.46				
LIQUID FLOW, BPSD	1698.07						46.21			2004.55
DENSITY AT P,T, LB/FT3	51.10	0.66	1.24		1.24	1.73	40.26		61.71	48.32
VISCOSITY AT P,T, CP	1.70	0.01	0.01		0.01	0.02	0.22		0.56	0.86
VAPOR COMPRESSIBILITY		1.07	1.07		1.07	1.05				
CONDUCTIVITY, BTU/M.F.FT	0.06	0.09	0.06		0.06	0.10	0.12		0.37	0.07
SURFACE TENSION, DYNE/CM	23.05								68.25	19.66
VAPOR FLOW AT P,T, ACFM		12.83	67.79		62.89	306.53				
LIQUID FLOW AT P,T, USGPM	55.39						1.82			59.55
ENTHALPY, MMBTU/H	2.38	-0.47	-1.73	11.21	-1.60	16.78	0.21	16.98	0.00	0.36

JET FUEL STUDY
JOB 5591
MTL BAL AREA
100 ELL, 500

DOE/AMOCO STUDY-05571
SECTION 300 - HYDROCRACKING
MATERIAL BALANCE
DOE/AMOCO STUDY-05571
SECTION 300 - HYDROCRACKING
MATERIAL BALANCE

STREAM ID	309	310
STREAM NAME	HP/LT VAPOR	PURGE GASES
PHASE	VAPOR	VAPOR
COMPOSITION, LBMOLS/H		
H2O	1.80	0.03
NH3		
H2S		
H2	2076.38	31.15
C1	153.52	2.30
C2	15.38	0.23
C3	16.00	0.24
C4	18.53	0.28
C5	1.72	0.03
150 F NBP	1.81	0.03
180 F NBP	0.88	0.01
212.5 F NBP	0.34	0.01
237.5 F NBP	0.20	
262.5 F NBP	0.11	
312.5 F NBP	0.14	
387.5 F NBP	0.03	
462.5 F NBP	0.01	
512.5 F NBP		
537.5 F NBP		
600 F NBP		
700 F NBP		
800 F NBP		
900 F NBP		
HCR FEED		
TOTAL FLOW, LBMOL/H	2286.85	34.31
LB/H	9368.80	140.50
TEMPERATURE, DEG.F	120.00	120.00
PRESSURE, PSIG	1635.00	1635.00
MOLECULAR WEIGHT	4.10	4.10
GRAVITY, DEG.API		
VAPOR FLOW, MMSCFD	20.83	0.31
LIQUID FLOW, BPSD		
DENSITY AT P,T, LB/FT3	1.03	1.03
VISCOSITY AT P,T, CP	0.01	0.01
VAPOR COMPRESSIBILITY	1.05	1.05
CONDUCTIVITY, BTU/H.F.FT	0.06	0.06
SURFACE TENSION, DYNE/CM		
VAPOR FLOW AT P,T, ACFM	151.45	2.27
LIQUID FLOW AT P,T, USGPM		
ENTHALPY, MMBTU/H	-2.90	-0.04

JET FUEL STUDY
JOB 5571
MTC BAL AREAS
100, 200, 300

2.2 Naphtha Stream

2.2.1 Naphtha Distillation & Hydrotreating (Area 600)

Operating conditions for the naphtha distillation and hydrotreater were provided to Lummus by Amoco and these conditions are presented in Table 2.1. The basic processing steps selected were a distillation to produce a 160°F+ feed stock and a fixed bed hydrotreater. Referring to drawing D5571-601 the flow is as follows:

- . The crude naphtha is charged to the Naphtha Distillation Column DA-601 via Surge Drum FA-601 and Feed Pump GA-601.
- . The column is reboiled with steam in EA-601 to produce a 160°F+ bottoms product.
- . The 160°F- overheads are condensed in EA-602 and sent to fuel via GA-603.
- . The 160°F+ Distillation Column bottoms is charged to the HDT Surge Drum FA-603 via GA-602.
- . 160°F+ naphtha is charged into the hydrotreater from Surge Tank FA-603 by Charge Pumps GA-604 through Feed/Effluent Exchanger EA-603.
- . The charge oil is combined with feed hydrogen gas from Heater EA-604 prior to entering the feed/effluent exchanger. The preheated mixture is then charged to the Reactor DC-601.
- . The Reactor DC-601 operates adiabatically with an average bed temperature of 450°F.
- . The effluent from DC-601 is cooled in EA-603 and flows through Exchangers EA-605 and EA-606. Process water is injected prior to EA-606 to convert the H₂S and NH₃ in the gas to an aqueous NH₄OH/NH₄HS solution.
- . The cooled mixture then passes into the High Pressure/Low Temperature Separator FA-605 where hydrogen rich gas leaves overhead. A portion of this high pressure gas is purged to remove H₂S and light gases from the loop and sent to the Rectisol Unit in the SNG plant to recover the hydrogen in the purge gas. The remaining gas is recirculated to Reactor DC-601.

- . The water phase from Separator FA-606 goes to the PHOSAM Unit in the SNG plant to recover the H_2S and NH_3 .
- . The hydrocarbon phase from Separator FA-606 is preheated in Exchanger EA-605 and charged to the HDT Naphtha Stabilizer DA-602 which is reboiled by MP Steam to stabilize the naphtha.
- . Offgas from the Naphtha Stabilizer is sent to the SNG plant for fuel.
- . The stabilized naphtha is cooled and sent to the Aromatics Recovery Unit (Area 700).

Table 2.1 Naphtha Hydrotreater Operating Conditions

Naphtha Hydrotreater Conditions	
Feed Stock	160°F+ Naphtha
Reactor Type	Fixed Bed
Number of Stages	1
LHSV Hr	1.0
Average Reactor Temperature	450°F
Reactor Pressure	500 psig H_2 Partial Pressure
H_2 Recycle Rate	2500 SCF/Bbl
Catalyst	Ni-Mo
Catalyst Replacement	2 years @ \$3/#

2.2.2 Aromatics Recovery Unit (Area 700)

This unit is based on the Shell Sulfolane Process licensed by Universal Oil Products. Referring to Drawings D5571-701A and B the flow is as follows:

Stabilized Naphtha from the Naphtha Hydrotreater (Area 600) is charged to the Extraction Column DA-701 through Feed Surge Drum FA-701 by Feed Charge Pump GA-701. Lean solvent is charged to the top of Column DA-701. As the feed flows through the column, aromatic components are selectively dissolved in the solvent. Raffinate with very low aromatics content is withdrawn from the top of DA-701.

Rich solvent leaves the bottom of the extractor. After heat exchange in Lean/Rich Solvent Exchanger EA-702, the rich solvent is charged to the top of DA-703, Stripper.

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The raffinate stream from the Extractor Column DA-701 overheads is cooled in Raffinate Cooler EA-701 and then contacted with wash water in Water Wash Column DA-702. Water removes any dissolved solvent from the raffinate. Raffinate leaving DA-702 overhead is pumped to Gasoline Blending Stock Storage. The solvent rich water from DA-702 flows to DA-705, Water Stripper.

Solvent accumulates in the bottom of Water Stripper DA-705 and is pumped back to the Recovery Column by Water Stripper Bottoms Pump GA-710. The rich water is returned to the Recovery Column DA-704 as stripping steam generated via the Water Stripper Reboiler EA-709 by exchange with the hot circulating lean solvent.

A solvent regeneration system is included to guard against excessive solvent degradation. In normal operation a slipstream of solvent is routed to the Solvent Regenerator DA-706. Degraded solvent is periodically withdrawn from the bottom of DA-706.

In the stripper, non-aromatic hydrocarbons, which are more volatile, are stripped from the solvent, removed overhead, condensed and recycled to the Extractor Column DA-701 for reuse.

The stripper bottoms consists of aromatics in the solvent. This stream is pumped to the Recovery Column DA-704 by Stripper Bottoms Pump GA-704.

In the Recovery Column DA-704, the aromatics are stripped from the solvent. Lean solvent leaves the column bottom and is returned to Extraction Column DA-701 by GA-707 Lean Solvent Pump after heat exchange in Water Stripper Reboiler EA-709 and Lean/Rich Solvent Exchanger EA-702.

The aromatic product recovered overhead from the Recovery Column is fractionated to recover benzene, toluene and xylene product streams.

The recovery column overhead is pumped by Recovery Column Overhead Pump GA-709 to Clay Tower Surge Tank FB-703. From FB-703 the aromatic stream is pumped by Clay Tower Feed Pump GA-715 through Clay Tower Feed/Effluent Exchanger EA-712, Clay Tower Feed Heater EA-713 and then into Clay Towers DA-707A/B. In the Clay Tower, trace amounts of unsaturates and residual non-hydrocarbon impurities are removed.

After heat exchange in the Clay Tower Feed/Effluent Exchanger, the extract flows to Benzene Column DA-708. Benzene product is withdrawn from a tray near the top of the tower. After cooling in Benzene Product Cooler EA-715, benzene flows to Benzene Day Tank FB-704. Product from FB-704 is pumped to product storage by Benzene Product Pump GA-719.

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Any water that accumulates in Benzene Column Reflux Drum FA-708 is pumped to Waste Treatment by Benzene Column Water Pump GA-718.

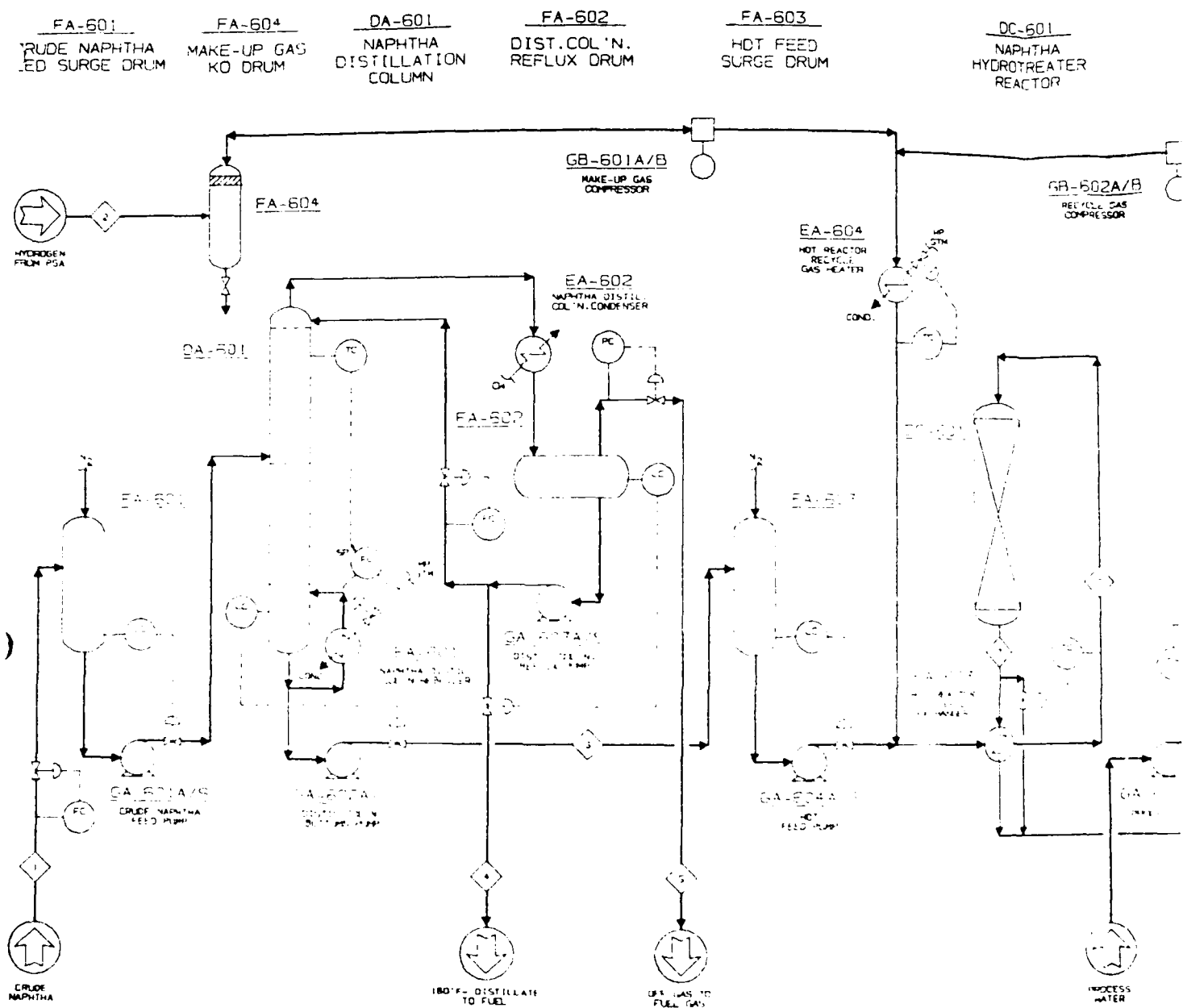
Benzene column bottoms are pumped by Benzene Column Bottoms Pump GA-716 to Toluene Column DA-709. The toluene product leaves overhead. Toluene is pumped from Toluene Column Reflux Drum FA-709 by Toluene Column Reflux Pump GA-721 through Toluene Product Cooler EA-720 to Toluene Day Tanks FB-706A/B. Toluene from FB-706A/B is pumped to storage by Toluene Product Pump GA-723.

Xylene is taken as bottoms product from Toluene Column DA-709. Xylene is pumped by Toluene Column Bottoms Pump GA-720 through Xylene Product Cooler EA-718 to Xylene Day Tank FB-705. Xylene from FB-705 is pumped to storage by Xylene Product Pump GA-722.

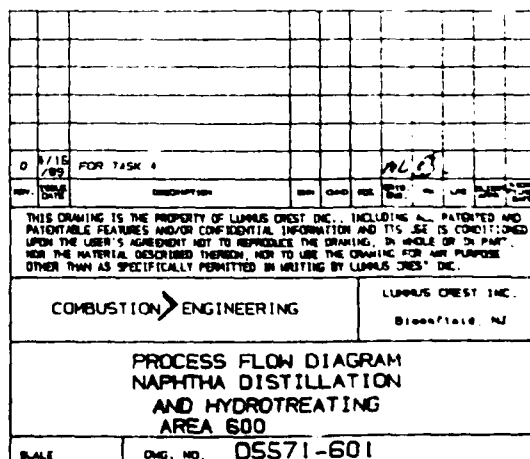
2.2 Naphtha Stream - cont'd

2.2.3 Process Flow Diagrams

<u>Dwg.</u>	<u>Title</u>
E5571-601	Naphtha Distillation and Hydrotreating
E5571-701A	Aromatics Recovery Unit Extraction Section
D5571-701B	Aromatics Recovery Unit Fractionation Section



FA-608
NAPHTHA STABIL.
REFLUX DRUM



V104-12550 ON 12/80

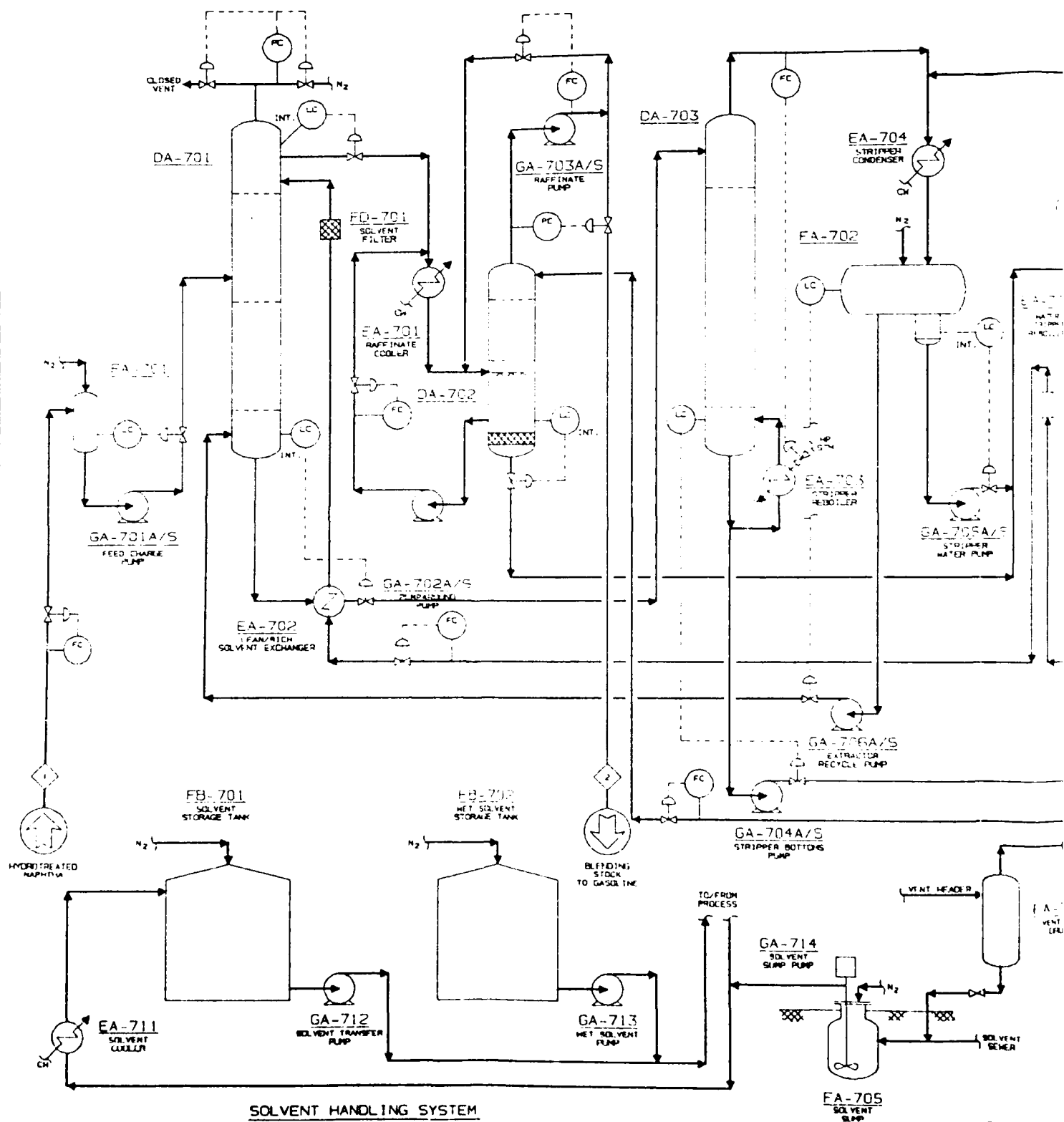
FA-701
FEED SURGE
DRUM

DA-701
EXTRACTOR
COLUMN

DA-702
RAFFINATE
WASH
COLUMN

DA-703
STRIPPER

FA-702
STRIPPER
REFLUX DRUM



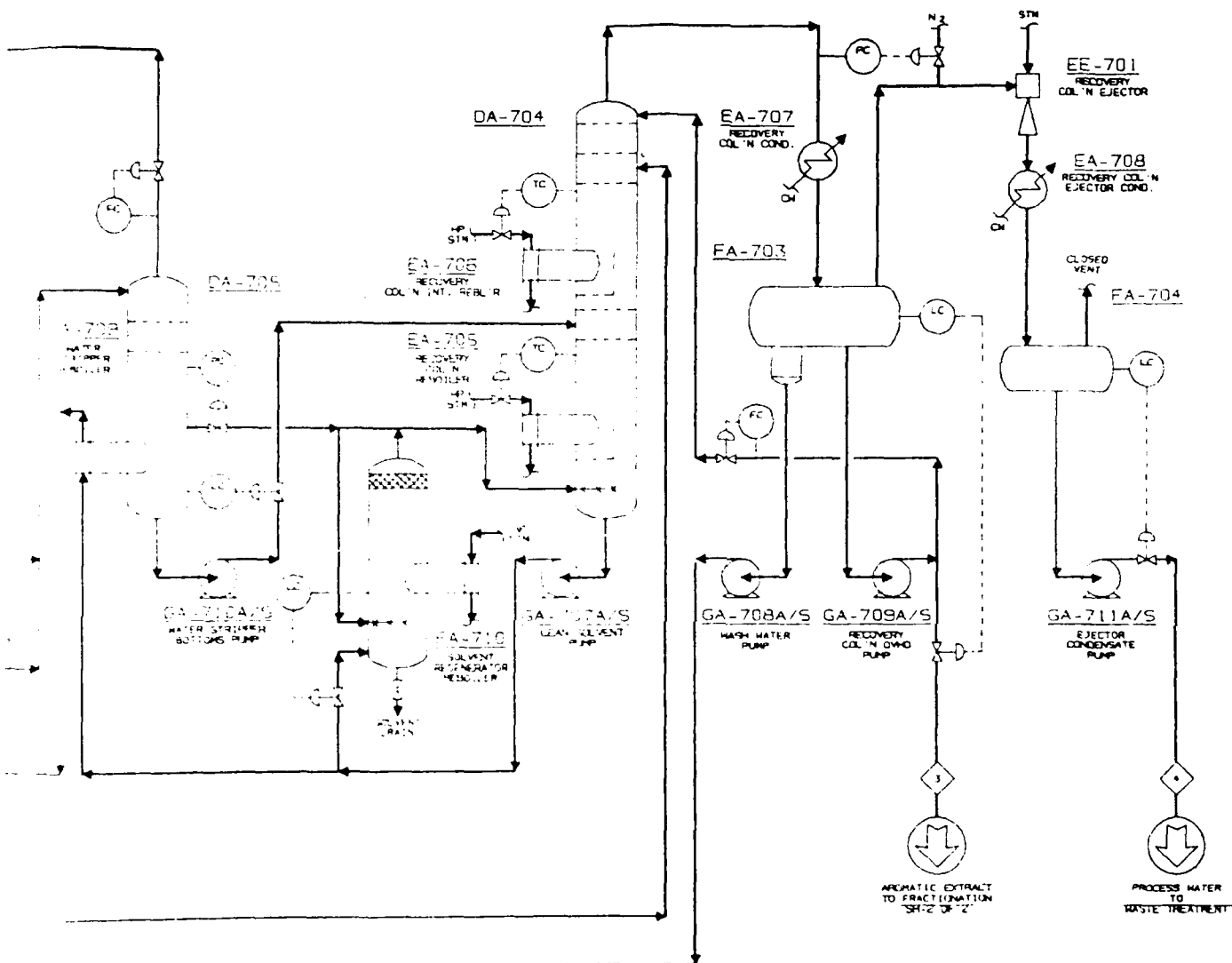
DA-705
WATER
STRIPPER

DA-706
SOLVENT
REGENERATOR

DA-704
RECOVERY
COLUMN

FA-703
RECOVERY
COLUMN REFLUX
DRUM

FA-704
EJECTOR CONDENSATE
DRUM



SHELL SULFOLANE PROCESS

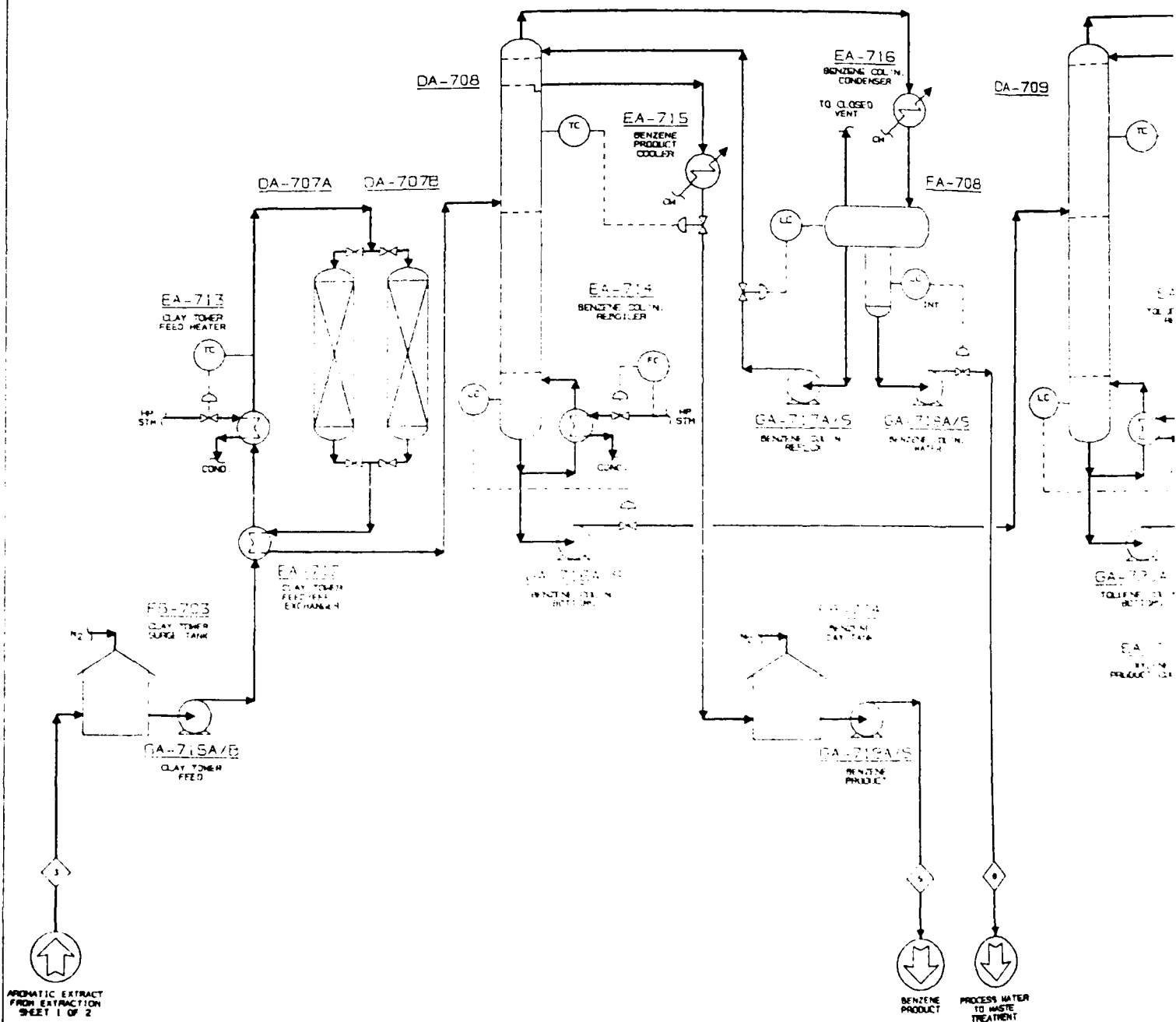
0		17/15/89		FOR TASK 4		MLB			
REV.	ISSUE DATE	DESCRIPTION	BY	CHKD	APP	DATE	FILE	DATE	FILE
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COMBUSTION ENGINEERING							LUPPUS CREST INC. Blountfield, NJ		
PROCESS FLOW DIAGRAM AROMATICS RECOVERY UNIT EXTRACTION SECTION AREA 700									
SCALE		DND. NO. D5571-701A							



DA-707A/B CLAY TOWERS BENZENE COLUMN

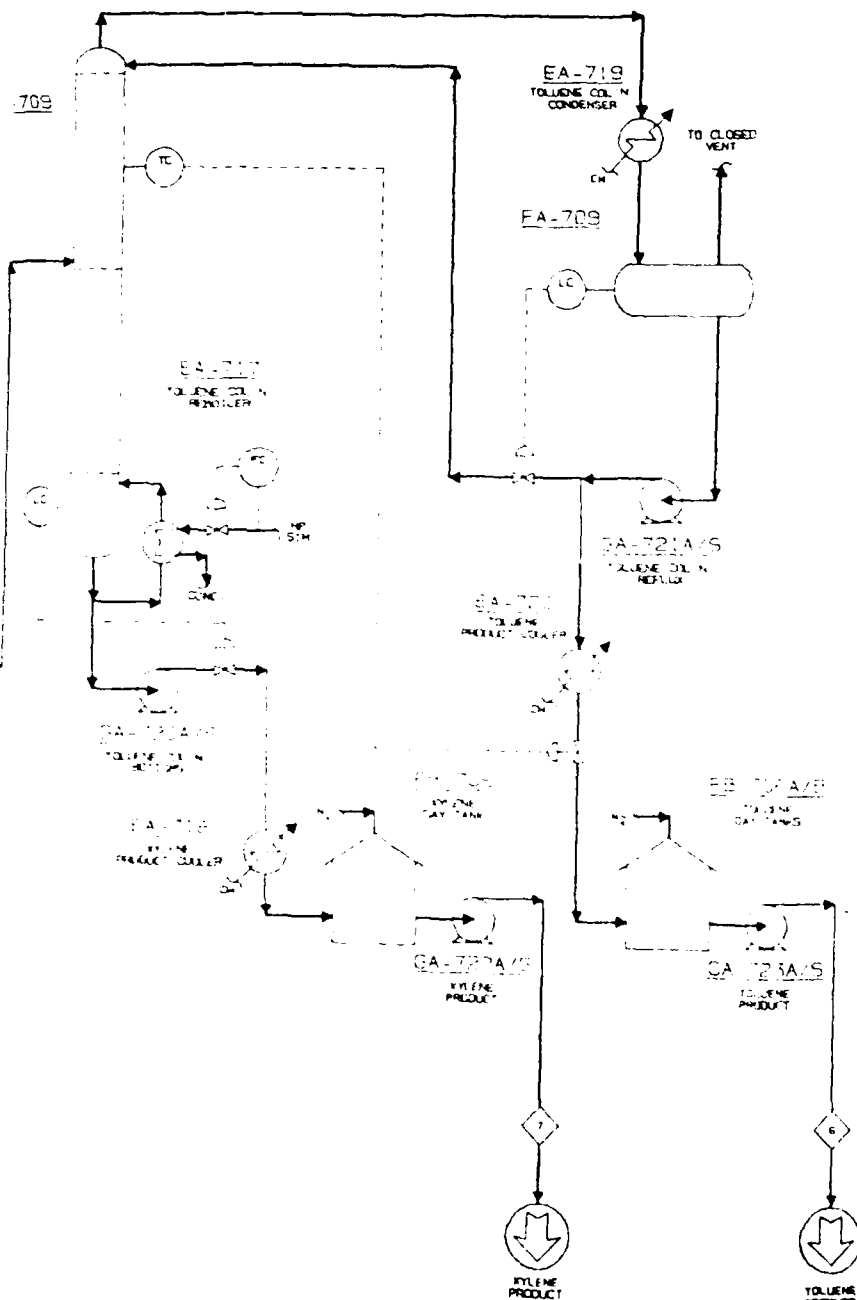
FA-708 BENZENE COLUMN REFLUX DRUM

DA-709 TOLUENE COLUMN



DA-709
TOLUENE COLUMN

FA-709
TOLUENE COLUMN
REFLUX DRUM



SHELL SULFOLANE PROCESS

0 1/15 FOR TASK 4									
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COMBUSTION ENGINEERING							LUMPLUS CREST INC. Blomfield, NJ		
PROCESS FLOW DIAGRAM AROMATICS RECOVERY UNIT AROMATICS FRACTIONATION SECTION AREA 700									
SCALE		DWS. NO. D5571-7018							

B-40

E1465
A
1350
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2.2 Naphtha Stream

2.2.4 Material Balances

600. The following Material Balances were developed for Area

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PROJECT GP JET FUELS
PROBLEM NAPSTAB

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AREA 600

NAPHTHA MDT PRODUCT STRIPPER

STREAM ID.....	12	13	15	17
STREAM NAME.....	SOUR M20	STAB PRD	STAB OFFGAS	STAB SOUR M20
STREAM PHASE.....	LIQUID	LIQUID	VAPOR	LIQUID

TEMPERATURE, DEG F	120.0000	287.5287	100.0000	100.0000
PRESSURE, PSIA	310.0000	70.0000	60.0000	60.0000
RATE LB MOLS/MR	167.1456	75.8282	8.4432	0.0309
RATE LB /MR	2661.4951	6135.1143	313.3105	0.5570
ENTHALPY MM BTU /MR	0.0780	0.6899	0.0653	0.0000
ENTHALPY BTU /LB	29.3213	112.4480	208.5772	67.9931
MOLECULAR WEIGHT....	18.0875	83.0998	37.1079	18.0150

*** VAPOR PHASE ***

RATE LB /MR	0.0000	0.0000	313.3105	0.0000
ACT.RATE FT3/SEC	0.00	0.00	0.23	0.00
STD.RATE MM FT3/DAY	0.00	0.00	0.08	0.00
CP, BTU /LB F	0.0000	0.0000	0.3973	0.0000
MOLECULAR WEIGHT....	0.0000	0.0000	37.1079	0.0000
ACT.DENS LB /FT3	0.0000	0.0000	0.3844	0.0000
COMPRESSIBILITY (Z)	0.0000	0.0000	0.9645	0.0000

*** LIQUID PHASE ***

RATE LB /MR	2661.4951	6135.1143	0.0000	0.5570
ACT.RATE BBL/DAY	185.82	576.27	0.00	0.04
STD. LV RATE BBL/MR	7.66	20.33	0.00	0.00
CP, BTU /LB F	1.1616	0.4890	0.0000	0.9977
MOLECULAR WEIGHT....	18.0875	83.0998	0.0000	18.0150
ACT.DENS LB /FT3	61.2244	45.5081	0.0000	61.9863
STD. API GRAVITY....	10.8966	32.5122	0.0000	10.0635

*** DRY BASIS ***

RATE LB /MR	37.6836	6135.1016	0.0000	0.0000
MOLECULAR WEIGHT....	25.1254	83.1004	0.0000	0.0000
UOPK	10.2499	10.0651	0.0000	0.0000
FLASH POINT, DEG F	-5.3046	0.7399	0.0000	0.0000
CRIT. TEMP, F	214.9373	561.6288	0.0000	0.0000
CRIT. PRES, PSIA	1412.3528	667.3295	0.0000	0.0000

*** VAPOR PHASE ***

RATE LB /MR	0.0000	0.0000	310.9178	0.0000
ACT.RATE FT3/SEC	0.00	0.00	0.22	0.00
STD.RATE MM FT3/DAY	0.00	0.00	0.00	0.00
CP, BTU /LB F	0.0000	0.0000	0.3971	0.0000
MOLECULAR WEIGHT....	0.0000	0.0000	37.1130	0.0000
ACT.DENS LB /FT3	0.0000	0.0000	0.3877	0.0000
COMPRESSIBILITY (Z)	0.0000	0.0000	0.9640	0.0000
VISCOSITY, CP	0.0000	0.0000	0.0102	0.0000

*** LIQUID PHASE ***

RATE LB /MR	37.6836	6135.1016	0.0000	0.0000
ACT.RATE BBL/DAY	4.67	576.27	0.00	0.00
CP, BTU /LB F	0.8241	0.4890	0.0000	0.0000
MOLECULAR WEIGHT....	25.1254	83.1004	0.0000	0.0000
ACT.DENS LB /FT3	39.6032	45.5080	0.0000	0.0000
STD. API GRAVITY....	8.7614	32.5122	0.0000	0.0000
VISCOSITY, CP	0.0000	0.0000	0.0000	0.0000

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AREA 600

REFINERY PROCESSOR PROPERTIES SET

STREAM ID.	5	6	7	8	9	10	11
STREAM NAME	MAKE-UP GAS	REACTOR INLE	REACTOR EFFL	WASH WATER	COLD SEP LIQ	PURGE GAS	RECYCLE GAS
STREAM PHASE	VAPOR	VAPOR	VAPOR	LIQUID	LIQUID	VAPOR	VAPOR
TEMPERATURE, DEG F	70.0000	425.0000	475.0000	100.0000	120.0000	120.0000	120.0000
PRESSURE, PSIA	340.0000	800.0000	775.0000	755.0000	710.0000	710.0000	710.0000
RATE, LB MOLS/NR	31.0000	277.0176	264.3793	138.7732	82.1024	5.3009	168.4035
RATE, LB /NR	62.5395	7324.1631	7321.4014	2499.9995	6446.4883	21.7711	691.6453
ENTHALPY MM BTU /NR	-0.0644	2.2362	2.5851	0.1750	C.2584	-0.0062	-0.1984
ENTHALPY BTU /LB	-1030.5195	305.3162	333.0820	69.9971	40.0906	-286.8285	-286.8286
MOLECULAR WEIGHT	2.0176	26.3822	27.6928	18.0150	78.3268	4.1071	4.1071
*** VAPOR PHASE ***							
RATE, LB /NR	62.5395	7324.1631	7321.4014	0.0000	C.0000	21.7711	691.6453
ACT. RATE, FT3/SEC	0.15	0.09	0.93	0.00	0.00	0.01	0.42
STD. RATE MM FT3/DAY	0.28	2.53	2.41	0.00	0.00	0.05	1.53
CP, BTU /LB F	3.4201	0.6138	0.6083	0.0000	C.0000	1.8091	1.8091
MOLECULAR WEIGHT	2.0176	26.3822	27.6928	0.0000	C.0000	4.1071	4.1071
ACT. DENS, LB /FT3	0.1189	2.2787	2.1894	0.0000	C.0000	0.4569	0.4569
COMPRESSIBILITY (Z)	1.0145	0.9757	0.9773	0.0000	C.0000	1.0260	1.0260
*** LIQUID PHASE ***							
RATE, LB /NR	0.0000	0.0000	0.0000	2499.9995	6446.4883	0.0000	0.0000
ACT. RATE, BBL/DAY	0.00	0.00	0.00	172.43	541.70	0.00	0.00
STD. LV RATE BBL/NR	0.00	0.00	0.00	7.15	21.83	0.00	0.00
CP, BTU /LB F	0.0000	0.0000	0.0000	0.9941	0.4159	0.0000	0.0000
MOLECULAR WEIGHT	0.0000	0.0000	0.0000	18.0150	78.3268	0.0000	0.0000
ACT. DENS, LB /FT3	0.0000	0.0000	0.0000	41.9844	50.8694	0.0000	0.0000
STD. API GRAVITY	0.0000	0.0000	0.0000	10.0635	36.1255	0.0000	0.0000
*** DRY BASIS ***							
RATE, LB /NR	0.0000	0.0000	0.0000	0.0000	6443.5264	0.0000	0.0000
ACT. RATE, FT3/SEC	0.0000	0.0000	0.0000	0.0000	78.4475	0.0000	0.0000
STD. RATE MM FT3/DAY	0.0000	0.0000	0.0000	0.0000	10.1772	0.0000	0.0000
UPP K	0.0000	0.0000	0.0000	0.0000	-75.8712	0.0000	0.0000
FLASH POINT, DEG F	0.0000	0.0000	0.0000	0.0000	515.0099	0.0000	0.0000
CRIT. TEMP, F	0.0000	0.0000	0.0000	0.0000	678.9440	0.0000	0.0000
CRIT. PRES, PSIA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
*** VAPOR PHASE ***							
RATE, LB /NR	62.5395	7316.9844	7187.2246	0.0000	0.0000	21.5452	686.6674
ACT. RATE, FT3/SEC	0.15	0.89	0.90	0.00	0.00	0.01	0.42
STD. RATE MM FT3/DAY	0.01	0.11	0.10	0.00	0.00	0.00	0.06
CP, BTU /LB F	3.4201	0.6139	0.6113	0.0000	C.0000	1.8233	1.8233
MOLECULAR WEIGHT	2.0176	26.3942	27.9733	0.0000	C.0000	4.0741	4.0741
ACT. DENS, LB /FT3	0.1189	2.2793	2.2128	0.0000	0.0000	0.4532	0.4532
COMPRESSIBILITY (Z)	1.0145	0.9756	0.9768	0.0000	C.0000	1.0261	1.0261
VISCOSITY, CP	0.0078	0.0185	0.0191	0.0000	C.0000	0.0106	0.0106
*** LIQUID PHASE ***							
RATE, LB /NR	0.0000	0.0000	0.0000	0.0000	6443.5264	0.0000	0.0000
ACT. RATE, BBL/DAY	0.00	0.00	0.00	0.00	541.49	0.00	0.00
STD. RATE MM FT3/DAY	0.0000	0.0000	0.0000	0.0000	C.4157	0.0000	0.0000
MOLECULAR WEIGHT	0.0000	0.0000	0.0000	0.0000	78.4475	0.0000	0.0000
ACT. DENS, LB /FT3	0.0000	0.0000	0.0000	0.0000	50.8694	0.0000	0.0000
STD. API GRAVITY	0.0000	0.0000	0.0000	0.0000	36.1255	0.0000	0.0000

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NAPHTHA FRACTIONATION

STREAM ID.	1	2	3	4
STREAM NAME	RECTISOL NAP 160 MINUS LIQUID	160 PLUS LIQUID	DIST OFFGAS VAPOR	
STREAM PHASE	LIQUID	LIQUID	VAPOR	
TEMPERATURE, DEG F	33.0000	100.0000	272.4216	100.0000
PRESSURE, PSIA	44.3253	40.0000	47.9999	40.0000
RATE, LB /HR	114.1908	35.9744	78.2163	
STD-RATE MM FT3/DAY	8737.9805	2168.0786	6570.0576	NORMALLY
CP, BTU /LB F	-0.0349	0.0386	0.4911	NO
ENTHALPY MM BTU /HR	-3.9967	17.8333	105.1917	FLOW
MOLECULAR WEIGHT	76.5209	60.2673	83.9986	
ACT-RATE, LB /HR	0.0000	0.0000	0.0000	0.0000
ACT-RATE FT3/SEC	0.00	0.00	0.00	0.00
STD-RATE MM FT3/DAY	0.00	0.00	0.00	0.00
CP, BTU /LB F	0.0000	0.0000	0.0000	0.0000
MOLECULAR WEIGHT	0.0000	0.0000	0.0000	0.0000
ACT-DENS, LB /FT3	0.0000	0.0000	0.0000	0.0000
COMPRESSIBILITY (Z)	0.0000	0.0000	0.0000	0.0000
ACT-RATE, LB /HR	8737.9805	2168.0786	6570.0576	0.0000
STD. LV RATE BBL/HR	713.18	208.33	607.62	0.00
CP, BTU /LB F	0.4193	0.5621	0.4886	0.0000
MOLECULAR WEIGHT	76.5209	60.2673	83.9986	0.0000
ACT-DENS, LB /FT3	52.3723	44.4841	46.2197	0.0000
STD. API GRAVITY	39.5750	60.6584	32.5314	0.0000
ACT-RATE, LB /HR	8693.9824	2124.0786	6570.0576	0.0000
MOLECULAR WEIGHT	77.7996	63.3648	83.9986	0.0000
UOP K	10.4363	11.4820	10.0981	0.0000
FLASH POINT, DEG F	-11.2329	-33.4546	19.7649	0.0000
CRIT. TEMP, F	530.7584	449.4239	565.6373	0.0000
CRIT. PRES, PSIA	665.3411	682.4471	658.0043	0.0000
ACT-RATE, LB /HR	0.0000	0.0000	0.0000	0.0000
ACT-RATE FT3/SEC	0.00	0.00	0.00	0.00
STD-RATE MM FT3/DAY	0.00	0.00	0.00	0.00
CP, BTU /LB F	0.0000	0.0000	0.0000	0.0000
MOLECULAR WEIGHT	0.0000	0.0000	0.0000	0.0000
ACT-DENS, LB /FT3	0.0000	0.0000	0.0000	0.0000
COMPRESSIBILITY (Z)	0.0000	0.0000	0.0000	0.0000
VISCOSITY, CP	0.0000	0.0000	0.0000	0.0000
ACT-RATE, LB /HR	8693.9824	2124.0786	6570.0576	0.0000
STD. LV RATE BBL/HR	710.17	205.30	607.62	0.00
CP, BTU /LB F	0.4169	0.5530	0.4886	0.0000
MOLECULAR WEIGHT	77.7996	63.3648	83.9986	0.0000
ACT-DENS, LB /FT3	52.3297	44.4255	46.2197	0.0000
STD. API GRAVITY	39.7.41	61.6516	32.5314	0.0000

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2.3 Phenol Stream

The basic design data for processing the crude phenol stream were provided to LCI by the Dakota Gasification Co. (3).

The unit is divided into 3 sections:

- Area 800 - Phenol Extraction
- Area 850 - Cresylic Acid Extraction
- Area 900 - Cresylic Acid Distillation

2.3.1 Phenol Extraction (Area 800)

Referring to Process Flow Diagram D5571-800 A,B and C the flow is as follows:

- . Crude phenol from the Great Plains Plant is charged to the flash column DA-801 from the surge drum FA-806 through pump GA-801. The recycle phenol stream from the Phenol Column DA-803 overhead is also charged to Column DA-801. The overhead from DA-801 is condensed by a 2 step condensation. Phenol is first condensed and refluxed back to the column and then a light oil/water mixture with phenol is condensed and decanted in Light Ends Drum FA-809. The phenol/light oil phase with dissolved water is pumped by GA-806 to the Light Ends Column DA-805. In the Flash Column phenol rich cresylic acid is separated from the tar residue. Phenol rich cresylic acid is side withdrawn and tar residue is pumped from the bottom of the column to the tar wash section.
- . The Flash Column overhead product enters the Light Ends Column DA-805. The overhead light ends product is sent to SNG plant fuel. Water condensed in the overhead drum is combined with the aqueous phase from the Light Ends Drum and sent to sour water treatment. The bottoms from the Light Ends Column are pumped and mixed with the phenol rich cresylic acid stream.
- . The side drawoff stream from DA-801 and the bottoms stream from DA-805 are sent to the Thin Film Evaporator ED-801. This combined stream contains the phenol, cresylic acid and neutral oil. This material is flashed over sulfuric acid to remove pyridine type substances. The vapor phase from ED-801 is dried in drier column DA-802, top vapor from the Dryer Column is condensed, hydrocarbon phase is refluxed back, aqueous phase is combined with the other water effluents. Bottoms from the Dryer Column is sent to the Phenol Column DA-803. Bottoms of ED-801 is mixed with the other tar streams.

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TASK 4.0

- . Cresylic acid from the Dryer Column, and the recycled phenol stream from cresylic acid distillation (Area 900) are charged to the Phenol Column DA-803 to produce an overhead stream which is returned to the Flash Column DA-801, a side draw stream of crude phenol and a bottoms stream which is pumped to the cresylic acid extraction (Section 850).
- . The crude phenol stream is stream stripped in a column to remove the impurities and produce a 99.8% pure phenol. This section is a Lummus proprietary design.
- . The combined tars are water washed in FD-8701/802, 1st and 2nd stage Water Wash Tanks, to remove acid materials and then routed to the Great Plains Fuel Pool.

2.3.2 Cresylic Acid Extraction (Area 850)

The basic processing step used in this section is a dual solvent extraction to recover the cresylic acid. Referring to Process Flow Diagram D5571-850 the flow is as follows:

- . The dephenolized cresylic acid from DA-803 is fed to the cresylic acid extraction area where it is extracted with hexane and methanol/water in Extractor Column DA-851.
- . Hexane enters the Extractor Column at the bottom and preferentially absorbs the oil components. The hexane/oil mixture exits the top of DA-851.
- . A methanol/water solution enters the top of the extractor column and preferentially adsorbs the phenolic compounds. The methanol/water/phenolic mixture exits the bottom of DA-851.
- . The oil components are stripped from the hexane in the Hexane Column DA-852. The hexane is recycled to Extractor Column DA-851. The oil is pumped by Hexane Column Bottoms Pump GA-852 through Neutral Oil Cooler EA-853 to the first stage Water Wash Tank FD-801.
- . Make-up Hexane is added as needed from Hexane Storage Tank FB-851 by GA-854 Hexane Make-Up Pump.

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TASK 4.0

- . The phenolics are recovered from the methanol/water solution in Methanol Column DA-853. The methanol/water is condensed overhead and refluxed to the Methanol Column by Methanol Column Reflux Pump GA-856. Methanol Make-up Drum FA-854 receives the overhead product from the Methanol Column, the methanol/water make-up and the condensate from the Drying Column DA-854. The phenolics are pumped to Drying Column DA-808 by Methanol Column Bottoms Pump GA-855 through Methanol Column Bottoms Cooler EA-856.
- . Drying Column DA-856 is reboiled to remove water carry-over from the phenolic product. The dry Crude Cresylic Acid leaves the bottom of DA-856. Product is pumped to either Cresylic Acid Distillation (Area 900) or through the Crude Cresylic Acid Cooler EA-861 to the Cresylic Acid Day Tank, FB-852 by Drying Column Bottoms Pump GA-858.
- . Crude Cresylic Acid from Cresylic Acid Day Tank is pumped to storage by Crude Cresylic Acid Pump GA-859.

2.3.3 Cresylic Acid Distillation (Area 900)

A two run block operation is used to separate the cresols and xylenols in the crude cresylic acid. In each block operation a series of distillation columns are used to progressively recover the higher boiling products.

2.3.3.1 Block Operation #1

In this block operation, four distillation columns are used. Referring to Process Flow Diagram D5571-900A the flow is as follows:

Dry crude cresylic acid from Cresylic Acid Extraction (Area 850) is charged to Phenol/Ortho Column DA-901. The overhead liquid distillate from this column is fed to Phenol Column DA-902. DA-901 bottoms is pumped through Phenol/Ortho Column Feed-bottoms Interchanger EA-909 and is fed to M,P-cresol Column DA-903.

The overhead liquid distillate from the Phenol Column DA-902 is recycled to the Phenol Column DA-803 in the 800 Area. DA-902 bottoms is pumped through Phenol Column Bottoms Cooler EA-910 to O-Cresol Topping Feed Day Tank FB-901. The o-Cresol Topping Pump sends the o-Cresol to intermediate storage.

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TASK 4.0

M,P-Cresol product is recovered overhead from M,P-Cresol Column DA-903. M,P-Cresol is pumped from M,P-Cresol Reflux Drum FA-903 through M,P-Cresol Product Cooler EA-912 to M,P-Cresol Product Cooler EA-912 to M,P-Cresol Day Tank FB-905. DA-903 bottoms is fed to Xylenol Topping Column DA-904.

The overhead liquid distillate from the Xylenol Topping Column DA-904 is recycled to M,P-Cresol Column DA-903. DA-904 bottoms is pumped through Xylenol Topping Bottoms Cooler EA-911 to Xylenol Intermediate Day Tank FB-902. From the day tank the xylenols are pumped to intermediate storage.

2.3.3.2 Block Operation #2

In this block operation, three distillation columns are used. Referring to Process Flow Diagram D5571-900B the flow is as follows:

O-Cresol from O-Cresol Topping Intermediate Storage FB-908 is charged to O-Cresol Topping Column DA-901. The overhead liquid distillate from this column is recycled to Crude Cresylic Acid Intermediate Storage FB-853. DA-901 bottoms is fed to O-Cresol Column DA-902.

O-Cresol product is recovered overhead from O-Cresol Column DA-902. O-Cresol is pumped from O-Cresol Reflux Drum FA-902 by O-Cresol Reflux Pump GA-904 through O-Cresol Product Cooler EA-914 to O-Cresol Day Tank FB-903. GA-913 pumps the O-Cresol product from FB-903 to O-Cresol Intermediate Storage FB-910. DA-902 bottoms is pumped by O-Cresol Bottoms Pump GA-903 through O-Cresol Column Bottoms Cooler EA-910 to Slop Cut Intermediate Storage FB-911.

Xylenols from Xylenol Intermediate Storage FB-909 are charged to 2,4/2,5 Xylenol Column DA-904. 2,4/2,5 Xylenol product is recovered overhead from DA-904. 2,4/2,5 Xylenol is pumped from 2,4/2,5 Xylenol Reflux Drum FA-904 by 2,4/2,5 Xylenol Reflux Pump GA-916 through 2,4/2,5 Xylenol Product Cooler EA-916 to 2,4/2,5 Xylenol Day Tank FB-906. GA-910 pumps the 2,4/2,5 Xylenol product from FB-906 to 2,4/2,5 Xylenol Storage FB-914. DA-904 bottoms contains Mixed Xylenols and is pumped by 2,4/2,5 Xylenol Bottoms Pump GA-915 through 2,4/2,5 Xylenol Column Feed-Bottoms Interchanger EA-915 and 2,4/2,5 Xylenol Column Bottoms Cooler EA-911 to Mixed Xylenols Day Tank FB-907. GA-908 pumps the Mixed Xylenols from FB-907 to Mixed Xylenols Storage FB-914.

References

- 1) "Summary of Design Basis Data" dated January 16, 1989 (Sheets 1 to 10).
- 2) LCI letter G.L. Hamilton to Dr. M. W. Forlong dated January 30, 1989 "LC-Finer, Hydrotreater and Hydrotreater Basis of Design".
- 3) Minutes of Meeting "Crude Phenol Processing" dated August 25, 1988 and Dakota Gasification letter 9440-DHD-88-067.

LCI PROJECT 5571
TASK 4.0

2.3 Phenol Stream - cont'd

2.3.4 Process Flow Diagrams

<u>Dwg.</u>	<u>Title</u>
E5571-800A	Phenol Extraction (Sheet 1 of 3)
E5571-800B	Phenol Extraction (Sheet 2 of 3)
E5571-800C	Phenol Extraction (Sheet 3 of 3)
E5571-850	Cresylic Acid Extraction
E5571-900A	Crude Cresylic Distillation Block Operation #1
E5571-900B	Crude Cresylic Distillation Block Operation #2

FA-806
CRUDE PHENOL
SURGE DRUM

FA-807
CRESYLIC ACID
DRUM

DA-801
FLASH
COLUMN

FA-801
FLASH COLUMN
REFLUX DRUM

FA-809
LIGHT ENDS
DRUM

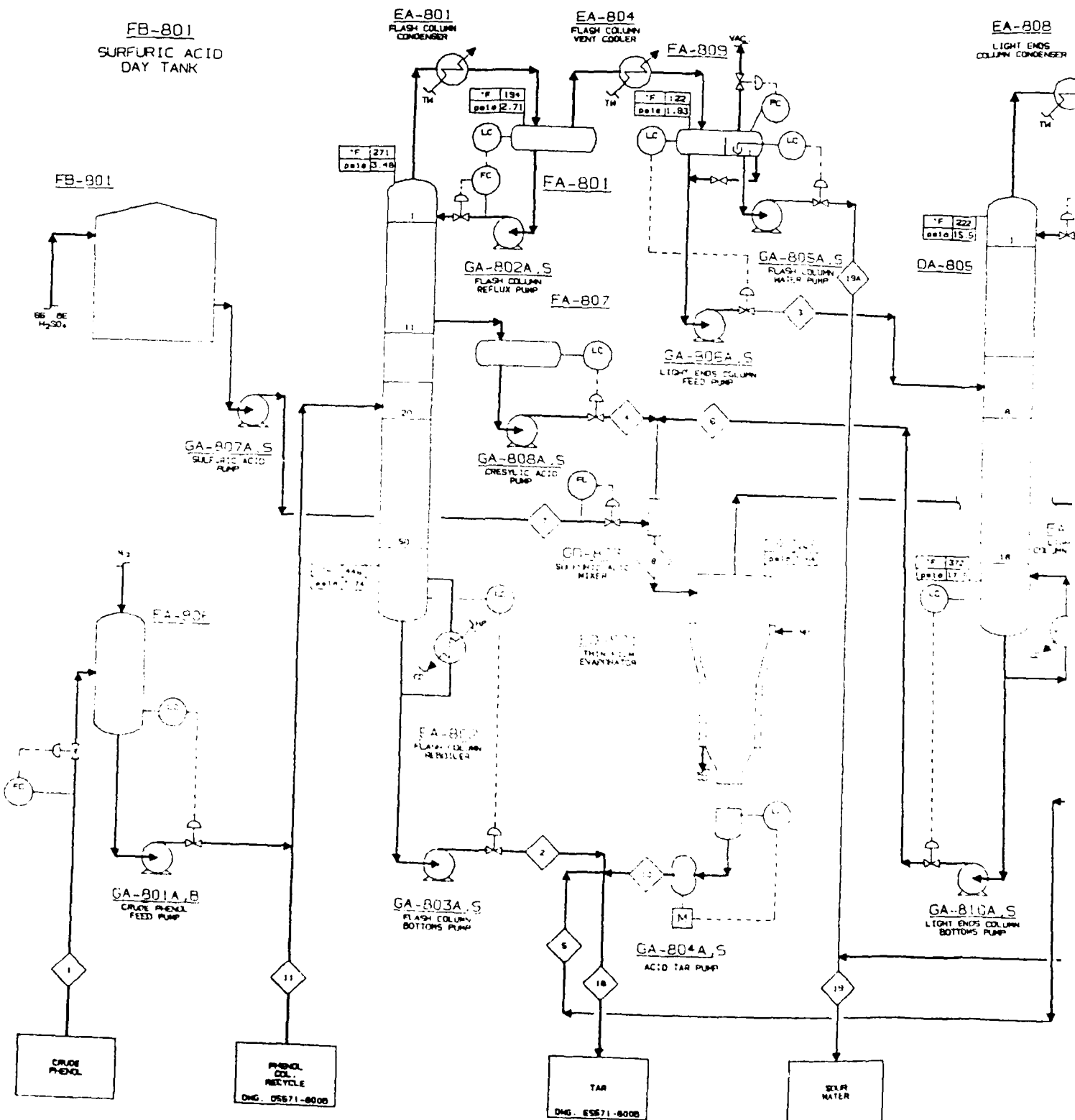
DA-805
LIGHT ENDS
COLUMN

FB-801
SURFURIC ACID
DAY TANK

EA-801
FLASH COLUMN
CONDENSER

EA-804
FLASH COLUMN
VENT COOLER

EA-808
LIGHT ENDS
COLUMN CONDENSER



DA-805
LIGHT ENDS
COLUMN

FA-805
LIGHT ENDS
COL. REFLUX DRUM

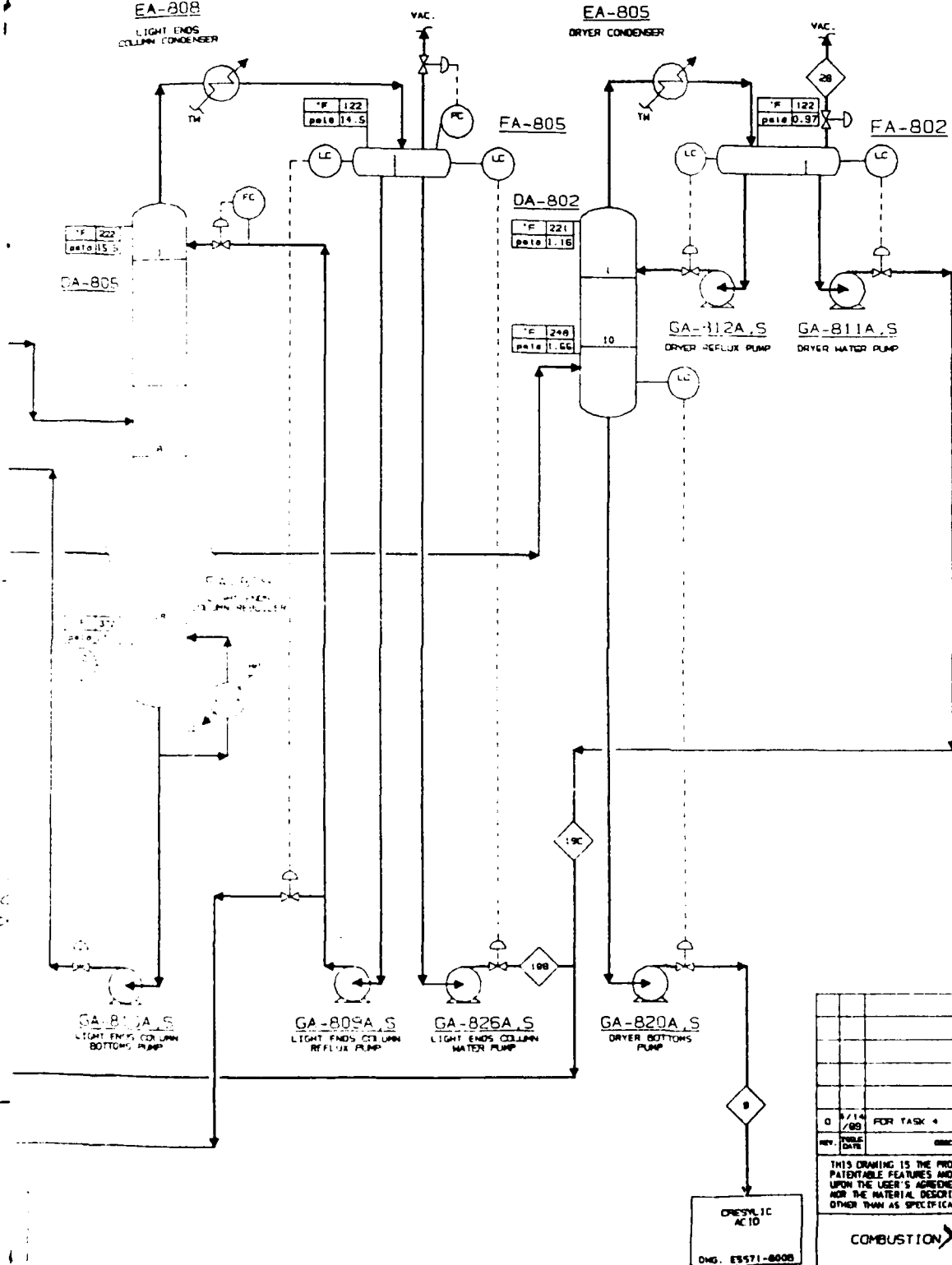
DA-802
DRYER

FA-802
DRYER
DRUM

NOTES:

EA-808
LIGHT ENDS
COLUMN CONDENSER

EA-805
DRYER CONDENSER



B-50

CRESOLIC
ACID

F1366



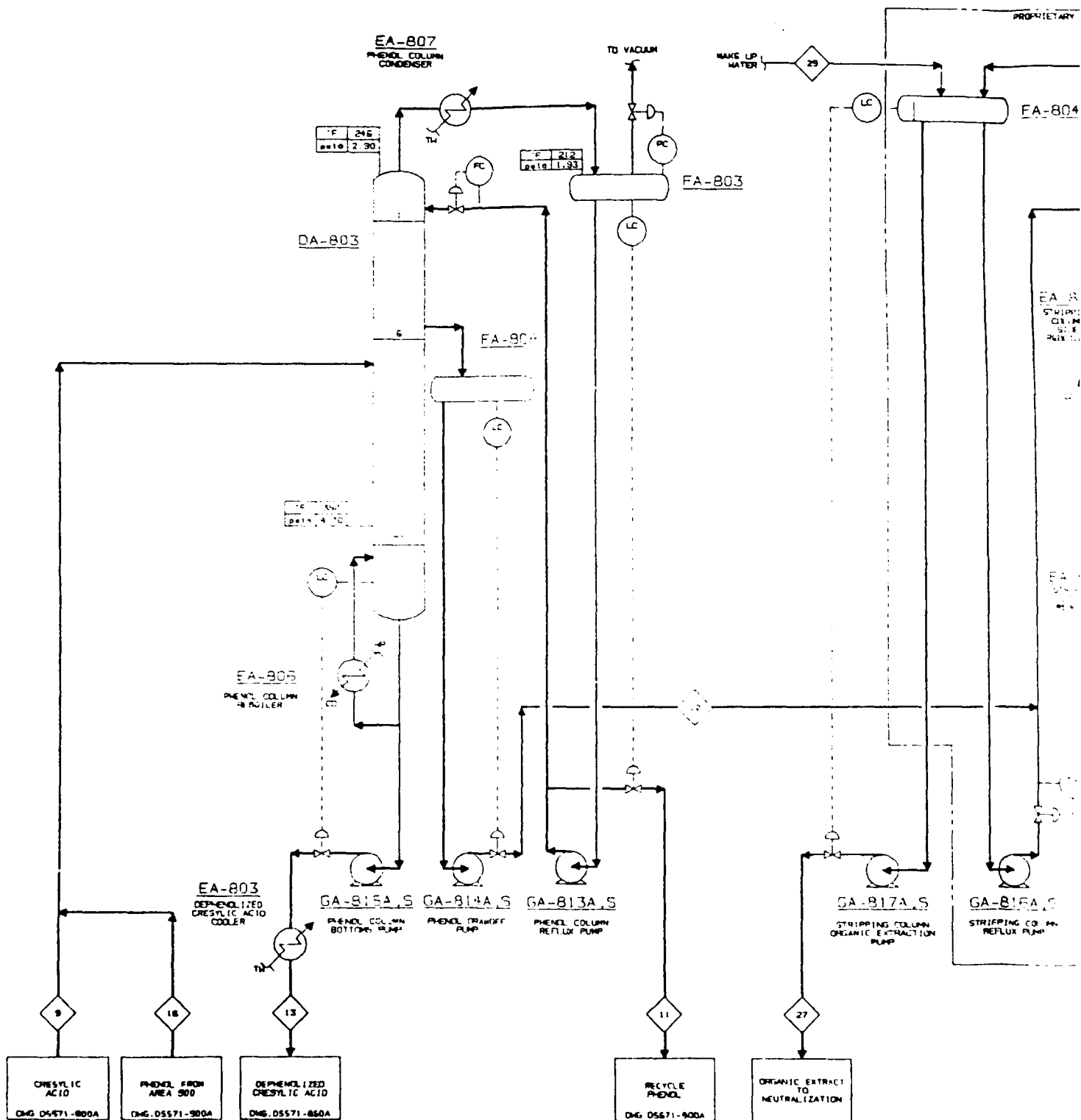
REV.		DATE	DESCRIPTION	DESIGNED BY	CHECKED BY	IN CHARGE	APPROVED BY
0	1/14/89		FOR TASK 4				
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COMBUSTION ENGINEERING				LINNUS OREST INC. Bloomfield, NJ			
PROCESS FLOW DIAGRAM PHENOL EXTRACTION							
SCALE		Dwg. NO. D5571-800A-0					

DA-803
PHENOL COLUMN

FA-808
PHENOL DRAWOFF
DRUM

FA-803
PHENOL COLUMN
REFLUX FRUM

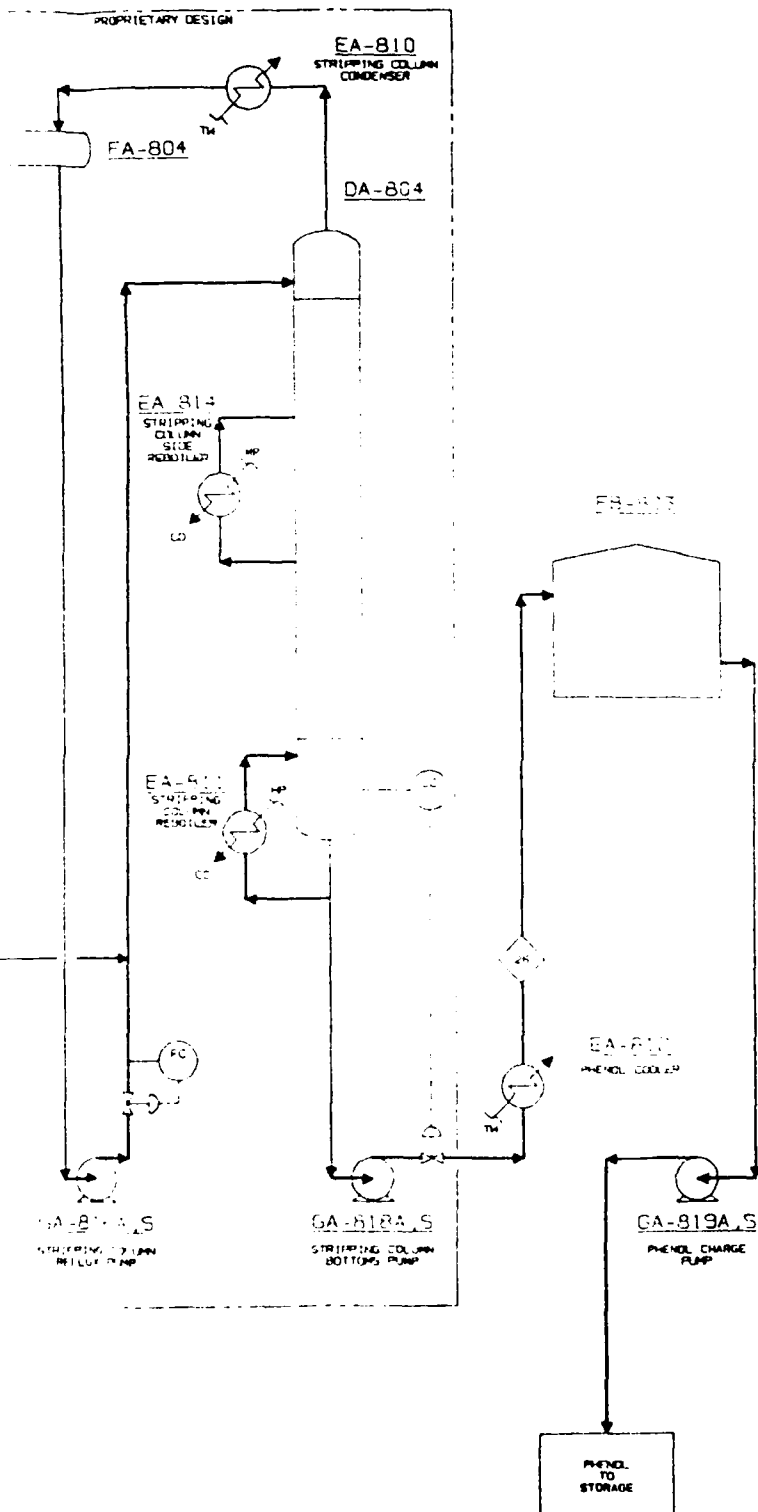
FA-804
STRIPPING COLUMN
REFLUX DRUM



DA-804 STRIPPING COLUMN
FB-803 PHENOL DAY TANK

NOTES:

1. FOR GENERAL NOTES, LEGEND AND SYMBOLS
SEE Dwg. NO.



B-51

F1367



Q 9/14/89 FOR TASK 1		RK	
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COMBUSTION ENGINEERING		PHENOL EXTRACTION	
SCALE	Dwg. NO 05571-8008-0		

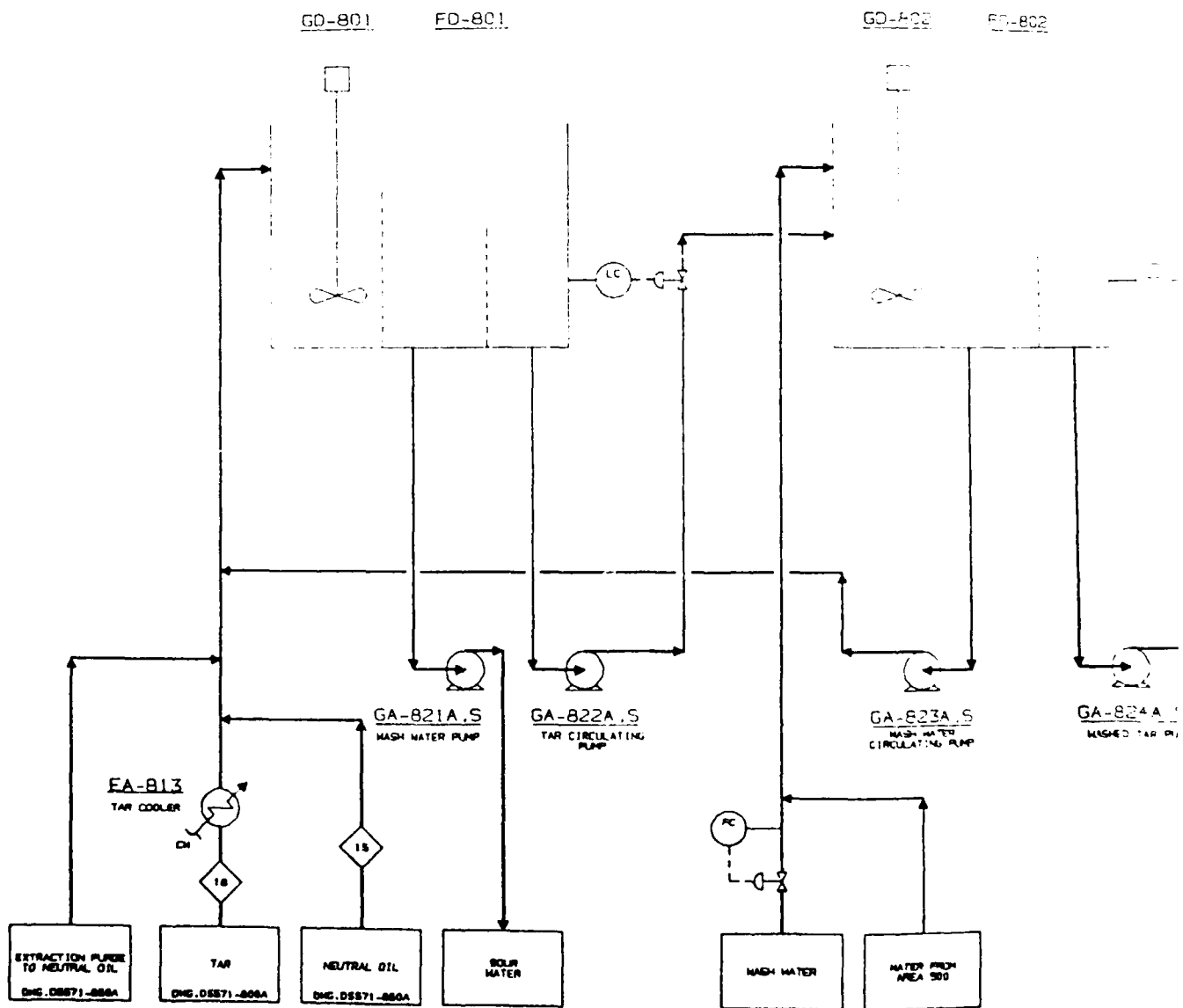
GD-801
FIRST STAGE MIXER

FD-801
FIRST STAGE WATER
WASH TANK

GD-802
SECOND STAGE MIXER

FD-802
SECOND STAGE
WASH TA

PLOT-0909 USER-D.COST 312 DR: IF1366 LOC: EXT: PAPER W DATE: 04/13/89



FD-802

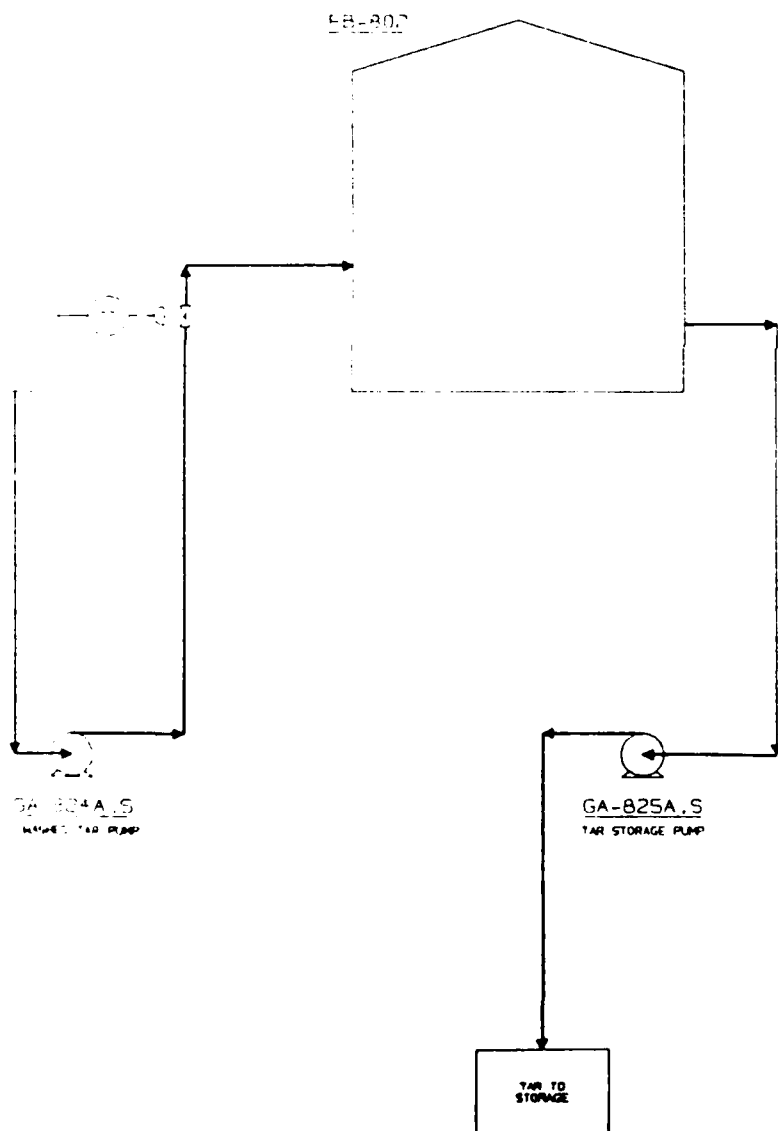
SECOND STAGE WATER
WASH TANK

FB-802

TAR DAY TANK

NOTES:

1. FOR GENERAL NOTES, LEGEND AND SYMBOLS
SEE DWG. NO.



0 8/14 7/89		FOR TASK 4		KLB	
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COMBUSTION ENGINEERING			LUPPUS CREST INC. Bloomsfield, NJ		
PHENOL EXTRACTION					
SCALE		DWC. NO. D5571-800C-0			

F1376



B-52



ANOL MAKE-UP
DRUM

CRUDE CRESYLIC
ACID DAY TANK

DRYING COLUMN
REFLUX DRUM

DRYING COLUMN

1. FOR GENERAL NOTES, LEGENDS AND SYMBOLS
SEE DMS. NO.



<div style="display: flex; justify-content: space-between;"> 0 9/14/80 FOR TASK 4 </div>											
REV.	DATE	DESCRIPTION	OWN	CHG	REV	REMARKS	REV	DATE	REMARKS	REV	DATE
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COMBUSTION > ENGINEERING								LUPPUS CREST INC. Bloomfield, NJ			
<h2>PROCESS FLOW DIAGRAM</h2> <h2>CRESYLIC ACID EXTRACTION</h2>											
SCALE		Dwg. NO.		D5571-850-0							

DA-901
PHENOL/ORTHO
COLUMN

FA-901
PHENOL/ORTHO O-CRESOL TOPPING
REFLUX DRUM

FB-901

DA-902A,B
PHENOL COLUMN

FA-902
PHENOL
REFLUX DRUM

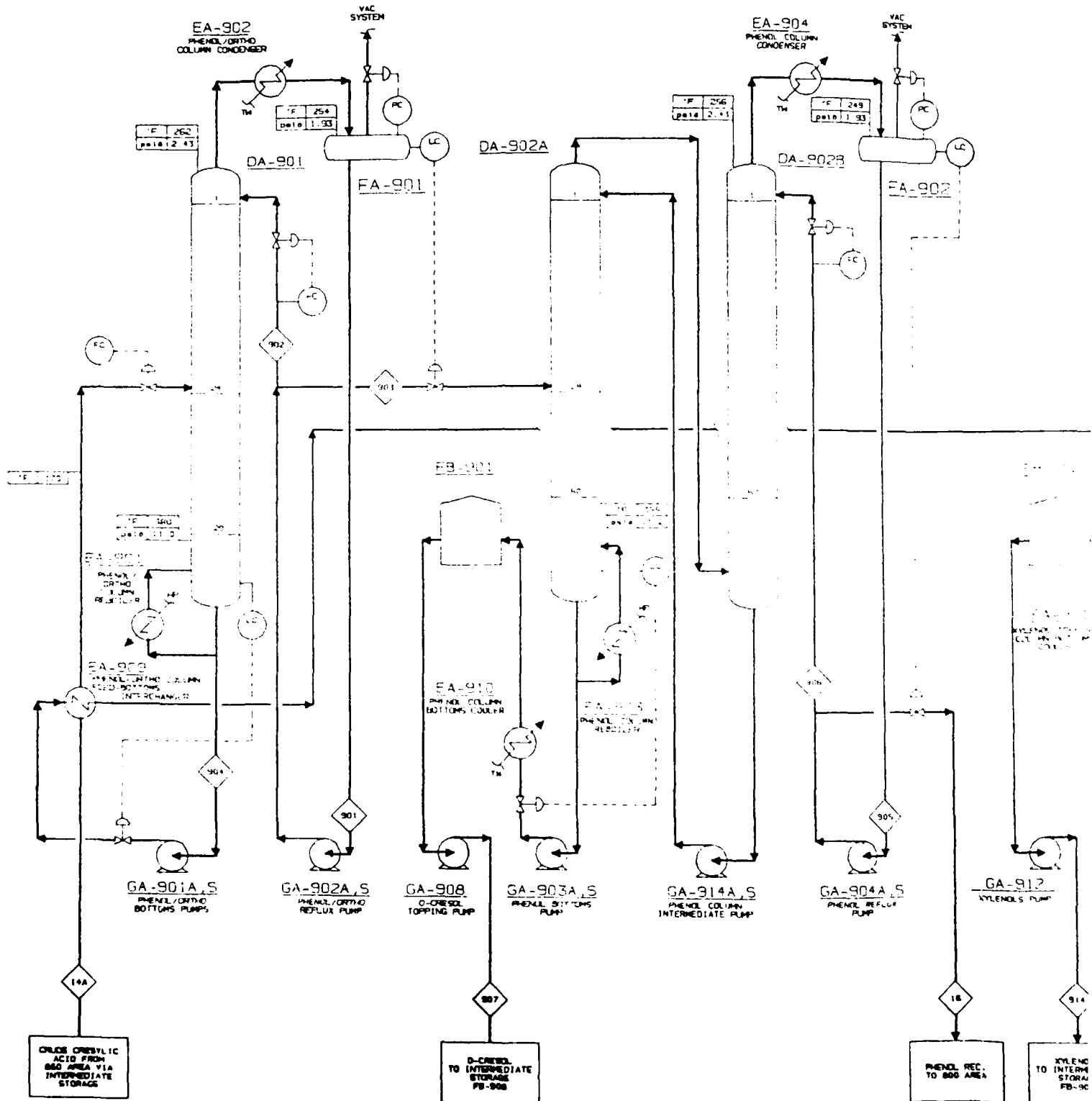
FB-902
XYLENOL
INTERMEDIATE
DAY TANK

EA-902
PHENOL/ORTHO
COLUMN CONDENSER

EA-904
PHENOL COLUMN
CONDENSER

VAC SYSTEM

VAC SYSTEM



FB-902
XYLENOL
INTERMEDIATE
DAY TANK

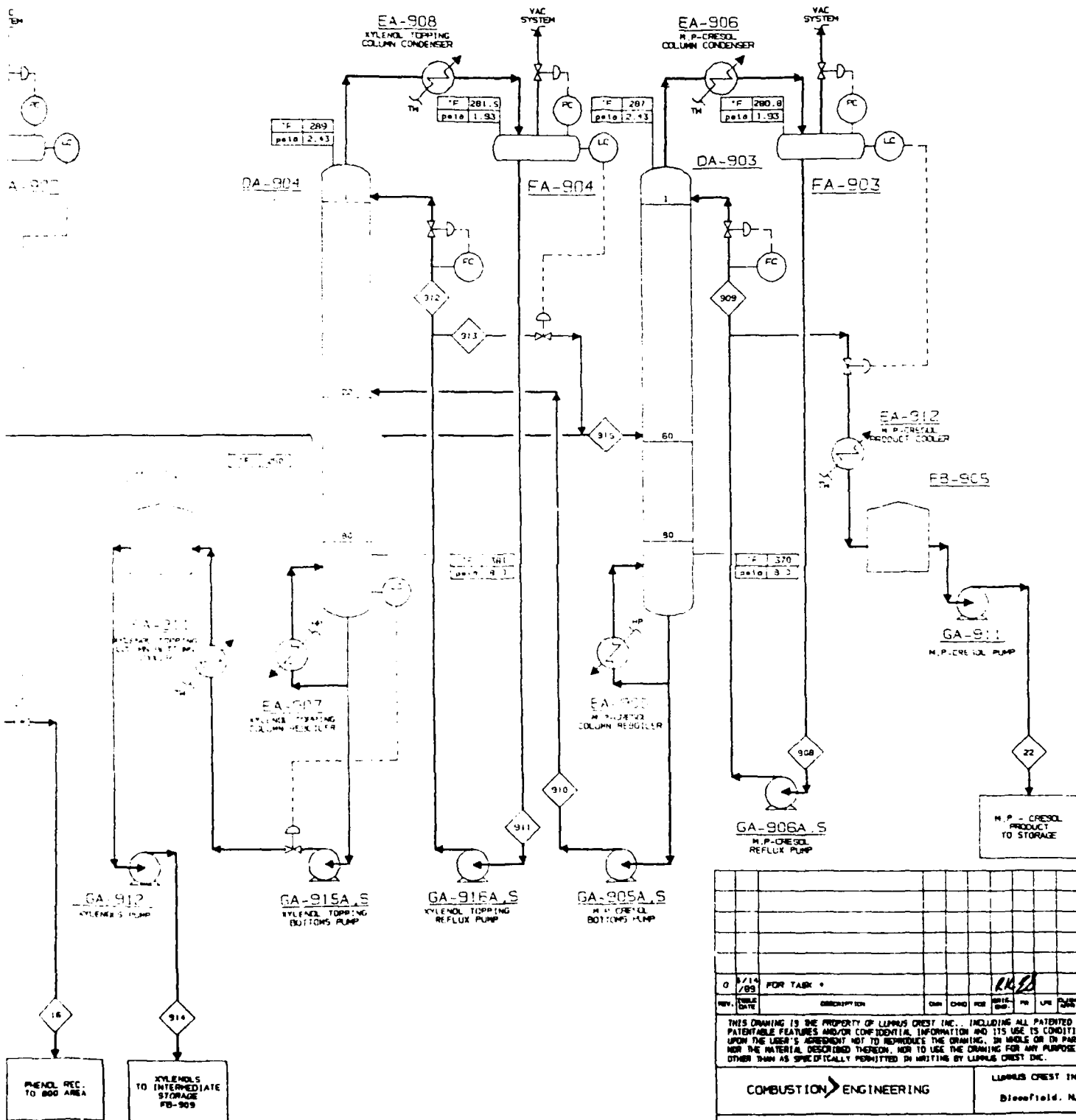
DA-904
XYLENOL
TOPPING
COLUMN

FA-904
XYLENOL TOPPING
REFLUX DRUM

DA-903
M,P-CRESOL
COLUMN

FA-903
M,P-CRESOL
REFLUX DRUM

FB-905
M,P-CRESOL
DAY TANK



0 8/14/89 FOR TASK # <i>142</i>									
REV.	DATE	DESCRIPTION	OWN	CHG	REV	DATE	REV	DATE	REV
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COMBUSTION ENGINEERING						LUPPUS CREST INC. Bloomfield, NJ			
PROCESS FLOW DIAGRAM CRUDE CRESYLIC DISTILLATION BLOCK OPERATION #1									
SCALE		DRG. NO. D5571-900A-0							

DA-901
O-CRESOL
TOPPING
COLUMN

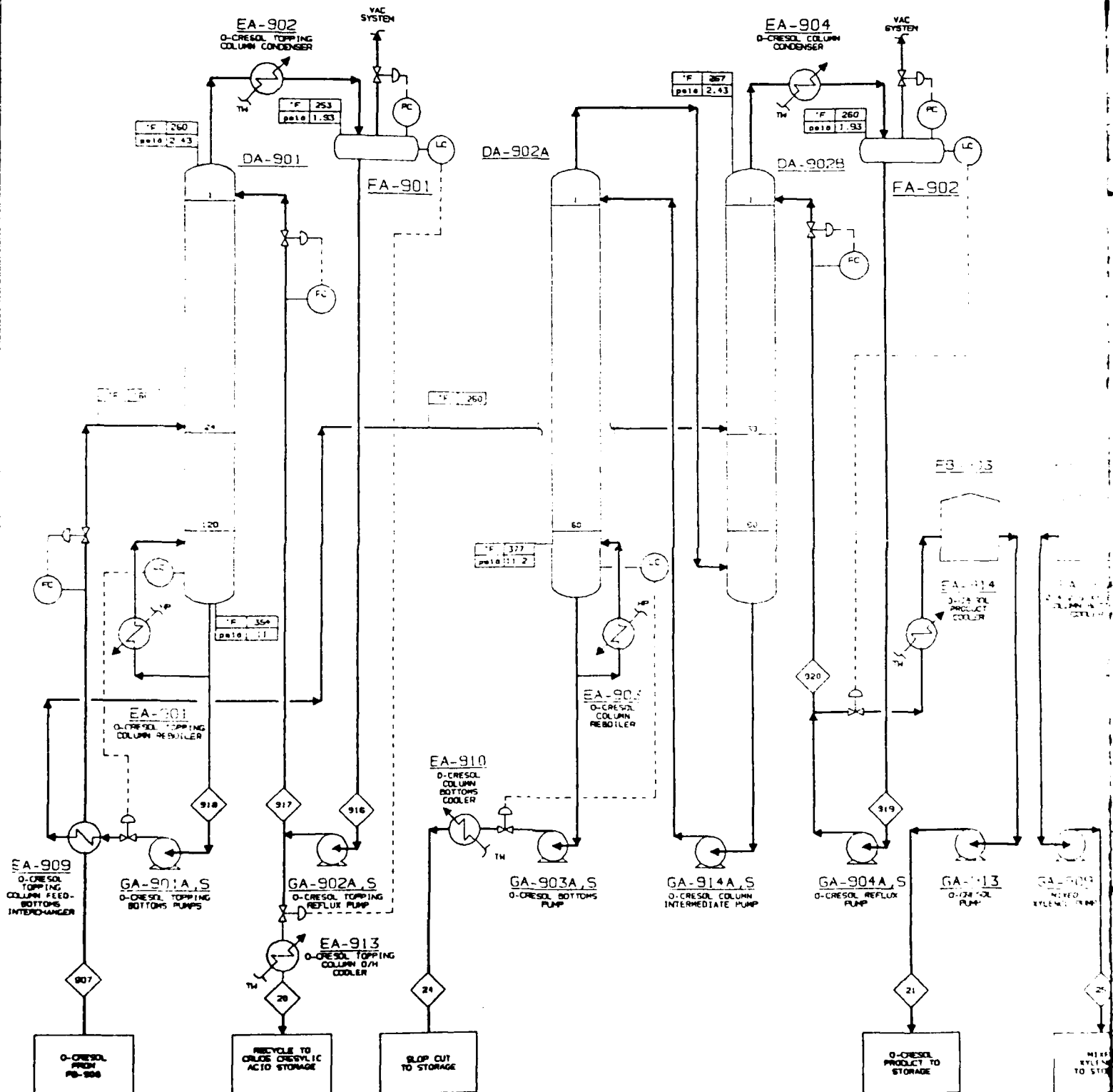
FA-901
O-CRESOL
TOPPING
REFLUX DRUM

DA-902A,B
O-CRESOL
COLUMN

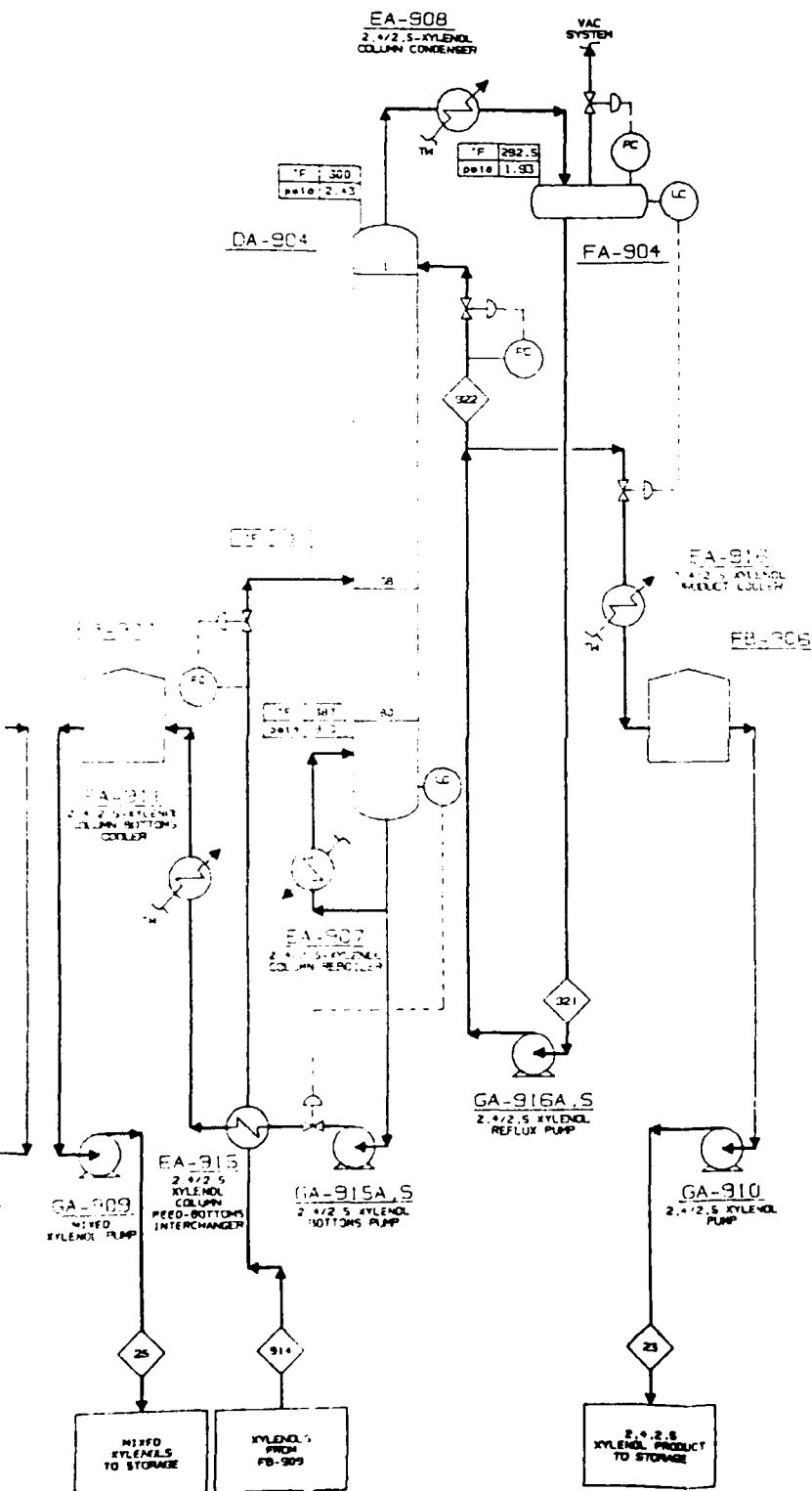
FA-902
O-CRESOL
REFLUX
DRUM

FB-903
O-CRESOL
DAY TANK

FB-907
MIXED XYLENOLS
DAY TANK



<u>DA-904</u>	<u>FA-904</u>	<u>F8-906</u>
2.4/2.5 XYLENOL	2.4/2.5 XYLENOL	2.4/2.5 XYLENOL
COLUMN	REFLUX DRUM	DAY TANK



<div style="display: flex; justify-content: space-between;"> <div> <p>0 5/14/95 FOR TASK 4</p> </div> <div> <p><i>KL</i></p> </div> </div>											
REV.	ISSUE DATE	DESCRIPTION	ENGR.	CHKD.	FILE	ISSUE DATE	FIG.	LINE	SCALE	UNIT	PROJECT NAME
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<p>COMBUSTION > ENGINEERING</p>								<p>LUMUS CREST INC. Bloomfield, NJ</p>			
<p style="text-align: center;">PROCESS FLOW DIAGRAM CRUDE CRESYLIC DISTILLATION BLOCK OPERATION #2</p>											
SCALE		<p>DWG. NO. D5571-900B-0</p>									

55

LCI PROJECT 5571
TASK 4.0

2.3 Phenol Stream - cont'd

2.3.5 Material Balance

The following Material Balances were developed for Areas 800, 850 and 900.

STAM LES HP	1 CRUDE PHENOL	2 BOTTOM DAB01	3 FEED DAB05	4 PHENOL DRAW	5 LIGHTEND PROD	6 BOTTOM DAB05	7 M2504 INJECTION	8 FEEL T.F.E
LIGHTS	244	0	244	4	244	0	0	4
PYRIDIN	141	141	0	0	0	0	0	0
PHENOL	3982	0	1156	3049	2	1154	0	4203
NEUTRAL OIL	411	0	39	373	0	39	0	412
O CRESOL	784	0	74	712	0	74	0	786
M CRESOL	1143	3	18	1122	0	18	0	1141
P CRESOL	809	2	13	795	0	13	0	808
GUAIACOL	103	0	2	101	0	2	0	103
O-ETHYLPHENOL	51	0	1	50	0	1	0	51
24XYLENOL	141	4	1	136	0	1	0	137
25XYLENOL	102	2	0	99	0	0	0	100
26XYLENOL	51	2	0	49	0	0	0	49
M-ETHYLPHENOL	102	42	0	60	0	0	0	61
P-ETHYLPHENOL	141	57	0	84	0	0	0	84
23XYLENOL	51	21	0	30	0	0	0	31
34XYLENOL	64	26	0	38	0	0	0	38
35XYLENOL	141	57	0	84	0	0	0	84
CATECHOL	1452	1479	0	17	0	0	0	17
RESIDUES	2921	2921	0	0	0	0	0	0
WATER	705	0	285	2	0	0	0	4
M2504	0	0	0	0	0	0	119	119
HEXANE	0	0	0	0	0	0	0	0
METHANOL	0	0	0	0	0	0	0	0
SULFUR DIOXIDE	0	0	0	0	0	0	0	0
TOTAL 8 HP	13551	4728	1821	6882	242	1311	121	6226
AFI	212	-11.9	51.9	21.7	20.2	0.4		21.5
SPGF	11.06	11.09	11.07	11.05	11.07	11.07	11.03	11.06
BSE	876	292	122	445	19	83	5	533

JET FUEL PROJECT
 AMOULES, GULAT PLANEAS
 JOB NO 3571
 MATERIAL BALANCE - 703 TON

STAN LBS. HF	9 FEED DABCO	10 T.F.E BOTTOM	11 PHENOL RECYCLE	12 PHENOL PRODUCT	13 EXTRACT FEED	14 FEED AREA900	15 NEUTRAL OIL	16 AREA900 RECYCLE
LIGHTS	4	0	4	0	0	0	0	0
PYRIDIN	0	0	0	0	0	0	0	0
PHENOL	3992	210	264	3651	679	605	74	602
NEUTRAL OIL	391	21	1	4	386	0	386	0
O CRESOL	747	39	2	1	745	685	60	1
M CRESOL	1084	57	1	1	1081	995	87	0
P CRESOL	767	40	1	0	766	705	61	0
BUTADIOL	98	5	0	0	98	90	8	0
O-ETHYLPHENOL	48	3	0	0	48	44	4	0
24XYLENOL	136	7	0	0	130	119	11	0
25XYLENOL	95	5	0	0	95	87	8	0
26XYLENOL	46	2	0	0	46	43	3	0
M-ETHYLPHENOL	55	6	0	0	55	51	4	0
P-ETHYLPHENOL	76	6	0	0	76	70	6	0
23XYLENOL	27	3	0	0	27	25	2	0
34XYLENOL	34	4	0	0	34	32	2	0
35XYLENOL	76	8	0	0	76	70	6	0
CATECHOL	12	1	0	0	12	11	1	0
RESIDUES	0	0	0	0	0	0	0	0
WATER	0	0	0	0	0	0	0	0
H2SO4	0	95	0	0	0	0	0	0
HEXANE	0	0	0	0	0	0	0	0
METHANOL	0	0	0	0	0	0	0	0
SULFUR DIOXIDE	0	0	0	0	0	0	0	0
TOTAL # HF	7682	519	272	3657	4355	3631	723	602
AFI	3.1	-7.9	-0.1	-0.7	6.0	4.4	14.3	-7.7
SFGF	1.05	1.15	1.08	1.08	1.03	1.04	0.97	1.08
BSC	501	31	17	232	290	239	51	35

STRM LBS/MF	18 TAR	19 SOUR WATER	19A AQU. PHASE OF FA-809	19B AQU. PHASE OF FA-805	19C SOUR WATER FR FA-802
LIGHTS	244	0	0	0	0
PYRIDIN	141	0	0	0	0
PHENOL	212	42	42	0	0
NEUTRAL OIL	21	0	0	0	0
O CRESOL	39	0	0	0	0
M CRESOL	60	0	0	0	0
P CRESOL	43	0	0	0	0
GUAIACOL	5	0	0	0	0
O-ETHYLPHENOL	3	0	0	0	0
24XYLENOL	11	0	0	0	0
25XYLENOL	8	0	0	0	0
26XYLENOL	5	0	0	0	0
M-ETHYLPHENOL	48	0	0	0	0
P-ETHYLPHENOL	65	0	0	0	0
23XYLENOL	24	0	0	0	0
34XYLENOL	30	0	0	0	0
35XYLENOL	65	0	0	0	0
CATECHOL	1440	0	0	0	0
RESIDUES	2930	0	0	0	0
WATER	0	710	416	285	7
H2SO4	98	TRACE	0	0	TRACE
HEXANE	0	0	0	0	0
METHANOL	0	0	0	0	0
SULFUR DIOXIDE	0	0	0	0	0
TOTAL #.HR	5493	752	460	265	7
API	-1.0				
SPGR	1.08	1.00	1.01	1.00	1.00
BSD	347	51	31	20	0

B-59

JET FUEL PROJECT
 ARCC ID#E - GREAT PLAINS T.M.F.
 JOB NO. 05571
 MATERIAL BALANCE - 100 AREA

STREAM LBS-HR	26 PHENOL PRODUCT	27 ORGANIC STREAM	28 VENT GAS	29 MAKE UP WATER
LIGHTS	0	0	0	0
PYRIDIN	0	0	0	0
PHENOL	3568	83	0	0
NEUTRAL OIL	4	0	0	0
O CRESOL	1	0	0	0
M CRESOL	1	0	0	0
P CRESOL	0	0	0	0
GUAIACOL	0	0	0	0
O-ETHYLPHENOL	0	0	0	0
24XYLENOL	0	0	0	0
25XYLENOL	0	0	0	0
26XYLENOL	0	0	0	0
M-ETHYLPHENOL	0	0	0	0
P-ETHYLPHENOL	0	0	0	0
23XYLENOL	0	0	0	0
34XYLENOL	0	0	0	0
35XYLENOL	0	0	0	0
CATECHOL	0	0	0	0
RESIDUES	0	0	0	0
WATER	0	1	4	1
H2SO4	0	0	0	0
METANE	0	0	0	0
METHANOL	0	0	0	0
SULFUR DIOXIDE	0	0	14	0
TOTAL 0-HR	3574	84	18	1
AFI	-0.7	-0.6		
SPGR	1.08	1.08		1.00
BSD	226	5		

[illegible]

STREAM NO.	851 VAPOR FF MECH COL	852 MECH COL BOTTOMS	853 COND. FF MECH COL	854 REFLE. TO MECH COL	855 COND. TO MECH MAKE UP DRUM	856 FEED TO DRYING COL	857 VAPOR FF DRYING COL	858 DECANTS WATER TO MECH MAKE UP DRUM	14 CRUDE CRESYLIC UP DRUM	
PHENOL		622.6				1009.6	404.9	18.9	605.0	
NEUTRAL D								0.0	0.0	
CHLOROL		690.9				911.7	226.7	5.9	685.0	
CHLOROL		1100.5				1162.8	167.9	7.5	995.0	
CHLOROL		710.0				803.9	119.7	5.3	705.0	
BLAIAOL		90.7				105.1	15.2	0.7	90.0	
CHETH LFF		44.7				51.4	7.4	0.3	44.0	
24X LENDL		119.0				132.2	13.1	0.3	119.0	
25X LENDL		27.0				96.7	9.7	0.2	27.0	
26X LENDL		47.1				47.0	4.3	0.1	47.0	
PHETHALPH		51.0				51.0	4.0	0.1	51.0	
PHETHALPH		70.0				75.4	5.4	0.2	70.0	
27X LENDL		20.0				26.9	1.9	0.1	20.0	
34X LENDL		30.0				34.5	2.5	0.1	30.0	
35X LENDL		70.0				75.4	5.4	0.2	70.0	
CATECHOL		10.0				11.4	0.4	0.0	11.0	
RESIDUES		0.0								
WATER	978.4	1547.9	978.4	600.0	270.0	675.0	675.0	1547.9		
HEXANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
METHANOL	1000.0	4.0	1000.0	570.0	350.0	5.2	8.2	4.0		
TOTAL W F	1078.4	5020.7	1028.4	600.0	390.0	570.1	1671.1	1594.0	2601.0	2601.0
TEMP. OF	150	150	150	150	150	110	300	110	400	110
DENSITY OF		60.0	47.0	47.0	47.0	60.0		61.0	50.0	60.0
SPM		10.00	27.00	10.00	10.00	10.00		3.22	6.50	7.0
S. G. E. O.									1.04	
AFI									4.4	
ESD									235	

JET FUEL PROJECT
 AMOULINE-CRIST PLAINS CHEM. CO.
 JOB NO. 08571
 MATERIAL BALANCE - 350 AREA

STREAM NO.	14	14A	901	902	903	904	905	906
	CRUDE	FEED TO	COND. FROM	REFLUX TO	FEED TO	PHENOL-ORTHO	COND. FROM	REFLUX TO
	CRESYLIC	PHENOL-ORTHO	PHENOL-ORTHO	PHENOL-ORTHO	PHENOL COL.	COL. BTMS.	PHENOL COL.	PHENOL COL.
	ACID	COLUMN	REFLUX DRUM	COLUMN			REFLUX DRUM	
PHENOL	605.0	710.0	6106.0	5396.0	710.0	0.0	6622.0	6020.0
NEUTRAL O	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O CRESOL	685.0	775.0	6665.0	5890.0	775.0	0.0	11.0	10.0
M-CRESOL	995.0	995.0	25.8	22.8	3.0	992.0	0.0	0.0
P CRESOL	705.0	705.0	17.2	15.2	2.0	703.0	0.0	0.0
GUAIACOL	90.0	90.0	0.0	0.0	0.0	90.0	0.0	0.0
O-ETHYLPN	44.0	44.0	0.0	0.0	0.0	44.0	0.0	0.0
24XYLENOL	119.0	119.0	0.0	0.0	0.0	119.0	0.0	0.0
25XYLENOL	87.0	87.0	0.0	0.0	0.0	87.0	0.0	0.0
26XYLENOL	43.0	43.0	34.4	30.4	4.0	39.0	0.0	0.0
M-ETHYLPN	51.0	51.0	8.6	7.6	1.0	50.0	0.0	0.0
P-ETHYLPN	70.0	70.0	0.0	0.0	0.0	70.0	0.0	0.0
23XYLENOL	25.0	25.0	0.0	0.0	0.0	25.0	0.0	0.0
34XYLENOL	32.0	32.0	0.0	0.0	0.0	32.0	0.0	0.0
35XYLENOL	70.0	70.0	0.0	0.0	0.0	70.0	0.0	0.0
CATECHOL	11.0	11.0	0.0	0.0	0.0	11.0	0.0	0.0
RESIDUES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEXANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MTHANOL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL #/H	3632.0	3827.0	12857.0	11362.0	1495.0	2332.0	6633.0	6030.0
TEMP., OF	77.0	77.0	253.4	253.4	253.4	379.6	249.0	249.0
DENSITY, #/CF	63.5	63.5	60.4	60.4	60.4	53.9	61.4	61.4
GPM	7.1	7.5	26.5	23.5	3.1	5.4	13.5	12.2
S.G. @60/60	1.04	1.04	1.06	1.06	1.06	1.02	1.08	1.08
API	4.4	4.4	2.0	2.0	2.0	7.2	-0.7	-0.7
BSD	239.3	252.1	831.1	734.4	96.6	156.6	420.8	382.6

JET FUEL PROJECT
 AMOCO 1006 UREAT PLANTS CASE 11
 JOBS NO 05571
 MATERIAL BALANCE - 900012A

STREAM NO.	16 PHENOL RECYCLE TO 800 AREA	907 FEED TO O-CRESOL TOPPING COL.	915 FEED TO M,P-CRESOL COLUMN	908 COND. FROM M,P-CRESOL REFLUX DRUM	909 REFLUX TO M,P-CRESOL COLUMN	22 M,P-CRESOL PRODUCT	910 FEED TO XYLENOL TOPP. COL.	911 COND. FROM XYLENOL TOPP. REFLUX DRUM
PHENOL	602.0	108.0	0.0	0.0	0.0	0.0	0.0	0.0
NEUTRAL O	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O CRESOL	1.0	774.0	0.0	0.0	0.0	0.0	0.0	0.0
M-CRESOL	0.0	3.0	1180.7	7432.5	6441.5	991.0	189.7	3207.9
P CRESOL	0.0	2.0	836.7	5265.0	4563.0	702.0	134.7	2272.9
GUAIACOL	0.0	0.0	107.0	675.0	585.0	90.0	17.0	289.0
O-ETHYLPH	0.0	0.0	52.4	330.0	286.0	44.0	8.4	142.8
24XYLENOL	0.0	0.0	137.5	37.5	32.5	5.0	132.5	314.5
25XYLENOL	0.0	0.0	100.5	30.0	26.0	4.0	96.5	229.5
26XYLENOL	0.0	4.0	41.4	292.5	253.5	39.0	2.4	40.8
M-ETHYLPH	0.0	1.0	50.0	0.0	0.0	0.0	50.0	0.0
P-ETHYLPH	0.0	0.0	70.0	0.0	0.0	0.0	70.0	0.0
23XYLENOL	0.0	0.0	25.0	0.0	0.0	0.0	25.0	0.0
34XYLENOL	0.0	0.0	32.0	0.0	0.0	0.0	32.0	0.0
35XYLENOL	0.0	0.0	70.0	0.0	0.0	0.0	70.0	0.0
CATECHOL	0.0	0.0	11.0	0.0	0.0	0.0	11.0	0.0
RESIDUES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEXANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THANOL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL #/H	603.0	892.0	2714.2	14062.5	12187.5	1875.0	839.2	6497.4
TEMP., OF	249.0	113.0	253.0	281.0	281.0	113.0	369.0	281.0
DENSITY, #/CF	61.4	64.4	58.1	58.0	58.0	63.3	53.2	57.8
GPM	1.2	1.7	5.8	30.2	26.2	3.7	2.0	14.0
S.G. 860/60	1.08	1.04	1.02	1.04	1.04	1.04	0.99	1.03
API	-0.7	5.1	7.2	5.1	5.1	5.1	11.4	5.9
BSD	38.3	58.8	182.3	926.5	802.9	123.5	58.1	432.2

JET FUEL PROJECT
ANDOLDBE - GREAT PLAINS GAS -
JOB NO 05571
MATERIAL BALANCE - 900 AREA

STREAM NO.	912 REFLUX TO XYLENOL TOPP COLUMN	913 RECYCLE TO M,P-CRESOL COLUMN	914 FEED TO XYLENOL COL.	916 COND. FROM O-CRESOL TOPP. COL.	917 REFLUX TO REC. TO CRUDE O-CRESOL TOPP. COL.	20 CRES ACID STORAGE	918 FEED TO O-CRESOL COL	919 COND. FROM O-CRESOL COL
PHENOL	0.0	0.0	0.0	1575.0	1470.0	105.0	3.0	33.0
NEUTRAL O	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O-CRESOL	0.0	0.0	0.0	1350.0	1260.0	90.0	684.0	7513.0
M-CRESOL	3019.2	188.7	1.0	0.0	0.0	0.0	3.0	0.0
P-CRESOL	2139.2	133.7	1.0	0.0	0.0	0.0	2.0	0.0
GUAIACOL	272.0	17.0	0.0	0.0	0.0	0.0	0.0	0.0
O-ETHYLPH	134.4	8.4	0.0	0.0	0.0	0.0	0.0	0.0
24XYLENOL	296.0	18.5	114.0	0.0	0.0	0.0	0.0	0.0
25XYLENOL	216.0	13.5	83.0	0.0	0.0	0.0	0.0	0.0
26XYLENOL	38.4	2.4	0.0	0.0	0.0	0.0	4.0	11.0
M-ETHYLPH	0.0	0.0	50.0	0.0	0.0	0.0	1.0	0.0
P-ETHYLPH	0.0	0.0	70.0	0.0	0.0	0.0	0.0	0.0
23XYLENOL	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0
34XYLENOL	0.0	0.0	32.0	0.0	0.0	0.0	0.0	0.0
35XYLENOL	0.0	0.0	70.0	0.0	0.0	0.0	0.0	0.0
CATECHOL	0.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0
RESIDUES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEXANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METHANOL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL #/H	6115.2	382.2	457.0	2925.0	2730.0	195.0	697.0	7557.0
TEMP., OF	281.0	281.0	113.0	253.0	253.0	113.0	354.0	260.4
DENSITY, #/CF	57.8	57.8	59.5	60.5	60.5	64.8	56.1	59.3
GPM	13.2	0.8	1.0	6.0	5.6	0.4	1.5	15.9
S.G. @60/60	1.03	1.03	0.97	1.07	1.07	1.07	1.05	1.05
API	5.9	5.9	14.4	0.7	0.7	0.7	3.3	3.4
BSD	406.8	25.4	32.3	187.3	174.8	12.5	45.5	493.1

JET FUEL PROJECT
 AMOCO 100% - GREAT PLAINS CASE
 JOB NO 05571
 MATERIAL BALANCE - 900000

STREAM NO.	920 REFLUX TO O-CRESOL COL	21 O-CRESOL PRODUCT	24 SLOP CUT	921 COND FROM XYLENOL REFLUX DRUM	922 REFLUX TO XYLENOL COL	23 2,4/2,5-XYL PRODUCT	25 MIXED XYLENOLS
PHENOL	30.0	3.0	0.0	0.0	0.0	0.0	0.0
NEUTRAL O	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O CRESOL	6830.0	683.0	1.0	0.0	0.0	0.0	0.0
M-CRESOL	0.0	0.0	3.0	16.0	15.0	1.0	0.0
P CRESOL	0.0	0.0	2.0	16.0	15.0	1.0	0.0
GUAIACOL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O-ETHYLPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24XYLENOL	0.0	0.0	0.0	1680.0	1575.0	105.0	9.0
25XYLENOL	0.0	0.0	0.0	1232.0	1155.0	77.0	6.0
26XYLENOL	10.0	1.0	3.0	0.0	0.0	0.0	0.0
M-ETHYLPH	0.0	0.0	1.0	16.0	15.0	1.0	49.0
P-ETHYLPH	0.0	0.0	0.0	0.0	0.0	0.0	70.0
23XYLENOL	0.0	0.0	0.0	0.0	0.0	0.0	25.0
34XYLENOL	0.0	0.0	0.0	0.0	0.0	0.0	32.0
35XYLENOL	0.0	0.0	0.0	0.0	0.0	0.0	70.0
CATECHOL	0.0	0.0	0.0	0.0	0.0	0.0	11.0
RESIDUES	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEXANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ETHANOL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL #/H	6870.0	687.0	10.0	2960.0	2775.0	185.0	272.0
TEMP., OF	260.4	113.0	113.0	292.5	292.5	113.0	113.0
DENSITY, #/CF	59.3	63.9	62.2	54.6	54.6	59.3	59.2
GPM	14.4	1.3	0.02	6.8	6.3	0.4	0.6
S.G. @60/60	1.05	1.05	1.02	0.97	0.97	0.97	1.03
API	3.4	3.4	7.9	15.1	15.1	15.1	5.7
BSD	448.3	44.8	0.7	209.1	196.0	13.1	18.1

JET FUEL PROJECT
 AMMO 1028 - GREAT PLAINS CASE
 JOB NO. 05571
 MATERIAL BALANCE - 900 P.M.

APPENDIX C

LCI Report on "Profitable JP-8" Design:
Capital Costs

3.0 CAPITAL COSTS

3.1 Equipment Lists

<u>AREA 100</u>	-	<u>HYDROTREATER</u>
<u>TAG NO.</u>	-	<u>DESCRIPTION</u>
BA-101		Preflash Heater
BA-102		Feed Heater
DA-101		Preflash Tower
DA-102		Atmospheric Tower
DA-103		Vacumm Tower
DC-101		Hydrotreater Reactor
DC-102		Hydrotreater Reactor
DC-103		Hydrotreater Reactor
EA-101		HVGO Condenser/BFW Exchanger
EA-102		LVGO Condenser
EA-103		Hot H.P. Separator Vapor/Steam Generator
EA-104		Hot L.P. Separator Vapor/BFW Exchanger
EA-105		Atmospheric Tower Reboiler
EA-106		Atmospheric Tower Overhead Condenser
EA-107		Fuel Gas Cooler
EA-108		Recycle Compressor Circulation Cooler
EC-101		Recycle Gas Cooler
EC-102		Preflash Tower Overhead Condenser
FA-101		Feed Surge Drum
FA-102		Hot H.P. Separator
FA-103		Hot L.P. Separator
FA-104		Interm. L.P. Separator
FA-105		Cold L.P. Separator
FA-106		HVGO Accumulator
FA-107		LVGO Accumulator
FA-108		Vacuum Hotwell
FA-109		Atmospheric Tower Feed Surge Drum
FA-110		Atmospheric Tower Overhead Accumulator
FA-111		Wash Water Surge Drum
FA-112		Water Seal Pot
FA-113		Water Collection Pot
FA-114		Fuel Gas K.O. Drum
FA-115		Recycle Compressor K.O. Drum
FA-116		Preflash Tower Overhead Drum

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREA 100 - HYDROTREATER

TAG NO. - DESCRIPTION

GA-101A/S	Feed Pump and Spare
GA-102A/S	Naphtha Quench Pump and Spare
GA-103A/S	HVGO Pump and Spare
GA-104A/S	LVGO Pump and Spare
GA-105	Slop Oil Pump
GA-106A/S	Sour Water Pump and Spare
GA-107A/S	Atmospheric Tower Overhead Pump and Spare
GA-108A/S	Vacuum Tower Bottoms Pump and Spare
GA-109	Reactor (DC-101) Recycle Pump
GA-110	Reactor (DC-102) Recycle Pump
GA-111	Reactor (DC-103) Recycle Pump
GA-112A/S	Wash Water Pump and Spare
GA-113A/S	HDS Feed Pump and Spare
GA-114A/S	Fresh Feed Pump and Spare
GA-115A/S	Preflash Tower Overhead Pump and Spare
GB-101A/S	Recycle Compressor and Spare
GB-102A/S	Fuel Gas Compressor and Spare
PA-101	Vacuum Ejector Package
PA-102A/S	Flame Arrester and Spare
PA-103	Corrosion Inhibitor Package
PA-104	Recycle Gas PSA Unit

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

<u>AREA 200</u>	<u>HDS and JP8 PRODUCTION</u>
<u>TAG NO.</u>	<u>DESCRIPTION</u>
BA-201	HDS Feed Heater
BA-202	JP8 Tower Feed Heater
DA-201	JP8 Tower
DA-202	JP8 Product Stripper
DA-203	Naphtha Stabilizer
DC-201	HDS Reactor
EA-201	HDS Reactor Feed/Effluent Exchanger
EA-202	JP8 Tower Feed/Bottoms Exchanger
EA-203	JP8 Tower Overhead Condenser
EA-204	Naphtha Stabilizer Feed/Bottoms Exchanger
EA-205	Naphtha Stabilizer Reboiler
EA-206	Naphtha Stabilizer Overhead Condenser
EA-207	Stabilized Naphtha Cooler
EA-208	Make-Up Hydrogen Compressor Circulation Cooler
EA-209	PSA Tail Gas Compressor After Cooler
EA-210	HDS Recycle Gas Compressor Circulation Cooler
EC-201	HDS Reactor Effluent Condenser
EC-202	JP8 Product Cooler
FA-201	HDS Feed Surge Drum
FA-202	HDS Reactor Effluent HP/LT Separator
FA-203	HDS Recycle Gas Compressor Suction K.O. Drum
FA-204	JP8 Tower Feed Surge Drum
FA-205	JP8 Tower Overhead Reflux/Product Drum
FA-206	Naphtha Stabilizer Overhead Reflux Drum
FA-207	PSA Feed Gas K.O. Drum
FA-208	Make-Up Hydrogen Compressor Suction K.O. Drum
FA-209	PSA Tail Gas K.O. Drum
GA-201A/S	HDS Feed Pump and Spare
GA-202A/S	JP8 Tower Overhead Reflux/Product Pump and Spare
GA-203A/S	JP8 Product Pump and Spare
GA-204A/S	JP8 Tower Bottoms and Spare
GA-205A/S	Naphtha Stabilizer Reflux Pump and Spare
GA-206A/S	HP Wash Water and Spare
GB-201A/S	HDS Recycle Gas Compressor and Spare
GB-202A/S	Make-Up Hydrogen Compressor and Spare
GB-203A/S	PSA Tail Gas Compressor and Spare
PA-201	Make-Up Hydrogen PSA Unit

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREA 300 HYDROCRACKING (525°F+ FEED)

TAG NO. DESCRIPTION

BA-301 HCR Feed Heater

DC-301 HCR Reactor

EA-301 HCR Reactor Feed/Effluent Exchanger

EA-302 HCR Recycle Gas Compressor Circulation Cooler

EC-301 HCR Reactor Effluent Condenser

FA-301 HCR Feed Surge Drum

FA-302 HCR Reactor Effluent HP/LT Separator

FA-303 HCR Recycle Gas Compressor K.O. Drum

GA-301A/S HCR Feed Pump and Spare

GB-301A/S HCR Recycle Gas Compressor and Spare

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

<u>AREA 400</u>	<u>STORAGE AREA</u>
<u>TAG NO.</u>	<u>DESCRIPTION</u>
FB-401	JP-8 Jet Fuel Storage Tank
FB-402	Stabilized Naphtha Storage Tank
FB-403	Fuel Oil Storage Tank
FB-404	300°F - Lt. Ends Storage
FB-405	Benzene Storage
FB-406	Toluene Storage
FB-407	Xylene Storage
FB-408	Gasoline Blend Storage
FB-409	Gasoline Storage
FB-804	Tar Product Storage
FB-805	Phenol Product Storage
FB-910	O-Cresol Storage
FB-912	M,P Cresol Storage
FB-913	2,4/2,5 Xylenol Storage
FB-914	Mixed Xylenol Storage
GA-401A/S	Tar/Tar Oil Feed Pump
GA-402A/S	Crude Phenol Feed Pump
GA-403A/S	Fuel Oil Transfer Pump
GA-404A/S	Stabilized Naphtha Transfer Pump
GA-405A/S	Crude Naphtha Transfer Pump
GA-406A/S	Gasoline Blending Stock Pump
GA-407A/S	Benzene Transfer Pump
GA-408A/S	Toluene Transfer Pump
GA-409A/S	Xylene Transfer Pump
GA-410A/S	JP-8 Transfer Pump
GA-411A/S	Gasoline Transfer Pump
GA-413A/S	300°F - Lt. Ends Transfer Pump
GA-414A/S	Tar Transfer Pump
GA-415A/S	Phenol Transfer Pump
GA-416A/S	O-Cresol Transfer Pump
GA-417A/S	M,P Cresol Transfer Pump
GA-418A/S	2,4/2,5 Xylenol Transfer Pump
GA-419A/S	Mixed Xylenol Transfer Pump
PA-401	Gasoline Blending Package

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

<u>AREA 500</u>	<u>CATALYST HANDLING</u>
<u>TAG NO.</u>	<u>DESCRIPTION</u>
FA-501	Catalyst Oil Drum
FA-502	Catalyst Storage Hopper
FA-503	Catalyst Transfer Vessel
FA-504	Spent Catalyst Vessels
FL-501	Catalyst Screen
GA-501A/S	Catalyst Transfer Pump
GA-502A/S	Catalyst Oil Pump
<u>AREA 600</u>	<u>NAPHTHA DISTILLATION & HDT</u>
EA-601	Naphtha Distillation Column Reboiler
EA-602	Naphtha Distillation Column Condenser
EA-603	HDT Reactor Feed/Effl. Exchanger
EA-604	HDT Reactor Recycle Gas Heater
EA-605	Stabilizer Feed Exchanger
EA-606	Reactor Effl. Cooler
EA-607	Stabilizer Reboiler
EA-608	Naphtha Stabilizer Condenser
EA-609	HDT Naphtha Cooler
FA-601	Crude Naphtha Feed Surge Drum
FA-602	Distillation Col'n Reflux Drum
FA-603	HDT Feed Surge Drum
FA-604	Make-Up Gas K.O. Drum
FA-606	LT/HP Separator
FA-607	Recycle Gas K.O. Drum
FA-608	Naphtha Stabilizer Reflux Drum
GA-601A/S	Crude Naphtha Feed Pump
GA-602A/S	Distillation Col'n Bottoms Pump
GA-603A/S	Distillation Col'n Reflux Pump
GA-604A/S	HDT Feed Pump
GA-605A/S	Process Water Pump
GA-606A/S	HDT Naphtha Pump
GA-607A/S	Naphtha Stabilizer Reflux Pump
GA-608A/S	Sour Water Pump
GB-601A/B	Make-Up Gas Compressor
GB-602A/B	Recycle Gas Compressor

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

<u>AREA 700</u>	<u>AROMATICS RECOVERY</u>
<u>TAG NO.</u>	<u>DESCRIPTION</u>
DA-701	Extractor Column
DA-702	Raffinate Water Wash Column
DA-703	Stripper
DA-704	Recovery Column
DA-705	Water Stripper
DA-706	Solvent Regenerator
DA-707A/B	Clay Tower
DA-708	Benzene Column
DA-709	Toluene Column
EA-701	Raffinate Cooler
EA-702	Lean/Rich Solvent Exchanger
EA-703	Stripper Reboiler
EA-704	Stripper Condenser
EA-705	Recovery Column Reboiler
EA-706	Recovery Column Intermediate Reboiler
EA-707	Recovery Column Condenser
EA-708	Recovery Column Ejector Condenser
EA-709	Water Stripper Reboiler
EA-710	Solvent Regenerator Reboiler
EA-711	Solvent Cooler
EA-712	Clay Tower Feed/Effl. Exchanger
EA-713	Clay Tower Feed Heater
EA-714	Benzene Column Reboiler
EA-715	Benzene Product Cooler
EA-716	Benzene Column Condenser
EA-717	Toluene Column Reboiler
EA-718	Xylene Product Cooler
EA-719	Toluene Column Condenser
EA-720	Toluene Product Cooler
EE-701	Recovery Column Ejector
FA-701	Feed Surge Drum
FA-702	Stripper Reflux Drum
FA-703	Recovery Column Reflux Drum
FA-704	Ejector Condensate Drum
FA-705	Solvent Sump
FA-706	Vent K.O. Drum
FA-708	Benzene Column Reflux Drum
FA-709	Toluene Column Reflux Drum

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREA 700

FB-701	Solvent Storage Tank
FB-702	Wet Solvent Storage Tank
FB-703	Clay Tower Surge Tank
FB-704	Benzene Day Tank
FB-705	Xylene Day Tank
FB-706A/B	Toluene Day Tanks
FD-701	Solvent Filter
GA-701A/S	Feed Charge Pump
GA-702A/S	Pumparound Pump
GA-703A/S	Raffinate Pump
GA-704A/S	Stripper Bottoms Pump
GA-705A/S	Stripper Water Pump
GA-706A/S	Extractor Recycle Pump
GA-707A/S	Lean Solvent Pump
GA-708A/S	Wash Water Pump
GA-709A/S	Recovery Column Overhead Pump
GA-710A/S	Water Stripper Bottoms Pump
GA-711A/S	Ejector Condensate Pump
GA-712	Solvent Transfer Pump
GA-713	Wet Solvent Pump
GA-714A/S	Solvent Sump Pump (Warehouse Spare)
GA-715A/S	Clay Tower Feed Pump
GA-716A/S	Benzene Column Bottoms Pump
GA-717A/S	Benzene Column Reflux Pump
GA-718A/S	Benzene Column Water Pump
GA-719A/S	Benzene Product Pump
GA-720A/S	Toluene Column Bottoms Pump
GA-721A/S	Toluene Column Reflux Pump
GA-722A/S	Xylene Product Pump
GA-723A/S	Toluene Product Pump
PA-701	Clay Handling Equipment

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREAS 800 & 850

PHENOL AND CRESYLIC ACID EXTRACTION

<u>TAG NO.</u>	<u>DESCRIPTION</u>
DA-801	Flash Column
DA-802	Drier Column
DA-803	Phenol Column
DA-804	Stripping Column
DA-805	Light Ends Column
DA-851	Extractor Column
DA-852	Hexane Column
DA-853	Methanol Column
DA-854	Drying Column
EA-801	Flash Column Condenser
EA-802	Flash Column Reboiler
EA-803	Dephenolized Cresylic Acid Cooler
EA-804	Flash Column Trim Cooler
EA-805	Dryer Condenser
EA-806	Phenol Column Reboiler
EA-807	Phenol Column Condenser
EA-808	Light Ends Column Condenser
EA-809	Light Ends Column Reboiler
EA-810	Stripping Column Condenser
EA-811	Stripping Column Reboiler
EA-812	Phenol Cooler
EA-813	Tar Cooler
EA-814	Stripping Column Side Reboiler
EA-851	Hexane Reboiler
EA-852	Hexane Condenser
EA-853	Neutral Oil Cooler
EA-854	Methanol Reboiler
EA-855	Methanol Condenser
EA-856	Methanol Column Bottoms Cooler
EA-857	Drying Column Reboiler
EA-858	Drying Column Condenser
EA-859	Crude Cresylic Acid Cooler
EA-860	65% Methanol Cooler
EA-861	Methanol Column Feed/Crude Cresylic Acid Interchanger
ED-801	Thin Film Evaporator

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREAS 800 & 850

PHENOL AND CRESYLIC ACID EXTRACTION

<u>TAG NO.</u>	<u>DESCRIPTION</u>
FA-801	Flash Column Reflux Drum
FA-802	Dryer Drum
FA-803	Phenol Column Reflux Drum
FA-804	Stripping Column Reflux Drum
FA-805	Light Ends Column Reflux Drum
FA-806	Crude Phenol Surge Drum
FA-807	Cresylic Acid Drum
FA-808	Phenol Drawoff Drum
FA-809	Light Ends Drum
FA-851	Hexane Reflux Drum
FA-852	Methanol Column Reflux Drum
FA-853	Drying Column Reflux Drum
FA-854	Methanol Make-Up Drum
FB-801	Sulfuric Acid Day Tank
FB-802	Tar Day Tank
FB-803	Phenol Day Tank
FB-851	Hexane Storage Tank
FB-852	Crude Cresylic Acid Day Tank
FB-853A/B	Crude Cresylic Acid Month Storage Tank
FD-801	1st Stage Water Wash Tank
FD-802	2nd Stage Water Wash Tank
GA-801A/S	Crude Phenol Feed Pump
GA-802A/S	Flash Column Reflux Pump
GA-803A/S	Flash Column Bottoms Pump
GA-804A/S	Acid Tar Pump
GA-805A/S	Flash Column Water Pump
GA-806A/S	Light Ends Column Feed Pump
GA-807A/S	Sulfuric Acid Pump
GA-808A/S	Cresylic Acid Pump
GA-809A/S	Light Ends Column Reflux Pump
GA-810A/S	Light Ends Column Bottoms Pump
GA-811A/S	Dryer Water Pump
GA-812A/S	Dryer Reflux Pump
GA-813A/S	Phenol Column Reflux Pump
GA-814A/S	Phenol Drawoff Pump
GA-815A/S	Phenol Column Bottoms Pump
GA-816A/S	Stripping Column Reflux Pump
GA-817A/S	Stripping Column Organic Extraction Pump
GA-818A/S	Stripping Column Bottoms Pump
GA-819A/S	Phenol Charge Pump
GA-820A/S	Dryer Column Bottoms Pump

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREAS 800 & 850

PHENOL AND CRESYLIC ACID EXTRACTION

GA-821A/S	Wash Water Pump
GA-822A/S	Tar Circulating Pump
GA-823A/S	Wash Water Circulating Pump
GA-824A/S	Tar Pump
GA-825A/S	Tar Storage Pump
GA-826A/S	Light Ends Column Water Pump
GA-851A/S	Extractor Bottoms Pump
GA-852A/S	Hexane Column Bottoms Pump
GA-853A/S	Hexane Feed Pump
GA-854A/S	Hexane Make-Up Pump
GA-855A/S	Methanol Column Bottoms Pump
GA-856A/S	Methanol Column Reflux Pump
GA-857A/S	Drying Column Feed Pump
GA-858A/S	Drying Column Bottoms Pump
GA-859	Crude Cresylic Acid Pump
GA-860A/S	Drying Column Condensate Pump
GA-861A/S	65% Methanol Pump
GA-862A/S	Crude Cresylic Acid Supply Pump
GD-801	1st Stage Wash Tank Mixer
GD-802	2nd Stage Wash Tank Mixer
GD-803	Sulfuric Acid Mixer
GD-851	Extractor Mixer
PA-801	Vacuum System

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREA 900 CRESYLIC ACID DISTILLATION

<u>TAG NO.</u>	<u>DESCRIPTION</u>	
	<u>BLOCK OPERATION 1</u>	<u>BLOCK OPERATION 2</u>
DA-901	Phenol/Ortho Column	O-Cres. Top. Column
DA-902A/B	Phenol Column	O-Cres. Column
DA-903	M,P Cresol Column	---
DA-904	Xylenol Top. Column	2,4/2,5-Xylenol Col.
EA-901	Phenol/Ortho Col. Reb.	O-Cres. Top Col. Reb.
EA-902	Phenol/Ortho Condenser	O-Cres. Top Condenser
EA-903	Phenol Column Reb.	O-Cres. Col. Reboiler
EA-904	Phenol Column Cond.	O-Cres. Col. Condenser
EA-905	M,P Cres. Col. Reb.	---
EA-906	M,P Cres. Col. Cond.	---
EA-907	Xylenol Top. Col. Reb.	2,4/2,5-Xyl. Col. Reb.
EA-908	Xylenol Top. Col. Cond.	2,4/2,5-Xyl. Col. Cond
EA-909	Phen./Ortho Col. Feed.	O-Cres. Top. Column
	Btms. Interchanger	Feed-Btms. Interchanger
EA-910	Phenol Col. Btms Cool.	O-Cres. Col. Btms. Cool.
EA-911	Xyl. Top. Col. Btms Cool.	2,4/2,5 Xyl. Col Btms Cool
EA-912	M,P Cres. Prod. Cool.	---
EA-913	---	O-Cres. Top. Col O/H Cool
EA-914	---	O-Cres. Product Cooler
EA-915	---	Xyl. Col. Feed Btms Intchg.
EA-916	---	2,4/2,5-Xyl. Prod. Cool.
FA-901	Phen/Ortho Reflux Drum	O-Cres. Top. Reflux Drum
FA-902	Phenol Reflux Drum	O-Cres. Reflux Drum
FA-903	M,P Cres. Reflux Drum	---
FA-904	Xyl. Top. Reflux Drum	2,4/2,5 Xyl. Ref. Drum
FB-901	O-Cresol Top. Feed	---
	Day Tank	---
FB-902	Xyl. Intermed. Day Tank	---
FB-903	---	O-Cres. Day Tank
FB-905	M,P Cresol Day Tank	---
FB-906	---	2,4/2,5 Xyl. Day Tank
FB-907	---	Mixed Xylenol Day Tank
FB-908	O-Cresol Topping Feed Month Storage	
FB-909	Xylenol Intermediate Month Storage	
FB-910	O-Cresol Month Storage	
FB-911	Slop Cut Month Storage	
FB-912	M,P Cresol Month Storage	
FB-913	2,4/2,5 Xylenol Month Storage	
FB-914	Mixed Xylenol Month Storage	

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREA 900

CRESYLIC ACID DISTILLATION

TAG NO.

DESCRIPTION

BLOCK OPERATION 1

BLOCK OPERATION 2

GA-901A/S	Phenol/Ortho Btms Pump	0-Cres. Top. Bottoms Pump
GA-902A/S	Phenol/Ortho Reflux Pump	0-Cres. Top. Reflux Pump
GA-903A/S	Phenol Bottoms Pump	0-Cres. Bottoms Pump
GA-904A/S	Phenol Reflux Pump	0-Cres. Reflux Pump
GA-905A/S	M,P Cres. Btms. Pump	---
GA-906A/S	M,P Cres. Reflux Pump	---
GA-908	0-Cres. Topping Pump	---
GA-909	---	Mixed Xylenol Pump
GA-910	---	2,4/2,5 Xylenol Pump
GA-911	M,P Cresol Pump	---
GA-912	Xylenol Pump	---
GA-913	---	0-Cresol Pump
GA-914A/S	Phen Col Intermed. Pump	0-Cres. Col. Inter. Pump
GA-915A/S	Xyl. Top. Btms. Pump	2,4/2,5 Xyl. Btms. Pump
GA-916A/S	Xyl. Top Return Pump	2,4/2,5 Xyl. Rflx. Pump
GA-917A/S	---	0-Cres. Top. Col. Feed
GA-918A/S	---	Xylenol Col. Feed Pump
PA-901	Vacuum Package	

3.2 Cost Estimate

3.2.1 Basis of Estimate

The estimates for all areas are equipment factored estimates. Data was developed for the equipment based on the processing schemes and then priced using in-house return cost data for similar equipment items. This equipment value was then used to establish the cost of materials and labor using historical ratio's of such costs. Engineering was calculated based on the number of equipment items. Contingency was added at 20% of the total costs. For Areas 500, 600 and 700 the Task 1.2 previous estimates are used, and escalated.

Excluded from this estimate are:

Spare Parts
Start-Up
Insurances & Taxes
Permits
Royalties on Processing Technology Knowhow

3.2.2 Estimate Summary

(Thousands of \$)

Area 100 Hydrotreater	\$ 25,992
Area 200 HDS & JP-8	34,761
Area 300 HDC	5,803
Area 400 OSBL	12,802
Area 500 Catalyst Handling	1,409
Area 600 Naph. Dist & HDT	5,403
Area 700 ARU	10,338
Area 800 Phenol Ext.	11,909
Area 850 Cresylic Acid Ext.	5,361
Area 900 Cresylic Acid Dist	7,508

\$121,287

Area 700 ARU Solvent Invent.	110
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Total	<u>\$121,397</u>
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3.2 Cost Estimate (cont'd)

3.2.3 ESTIMATE BREAKDOWN

The following pages show the estimate breakdown for each Area. The backup for the estimate can be found in Section 6 along with the equipment data.

AREA 100

LCI PROJECT 5571
TASK 4.0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571
PAGE:1
DATE/BY: 21-Apr-89
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EQUIPMENT # PCS. \$ EQUIP. # COMM \$ COMM

<u>HEATERS</u>	2	\$485	80%	\$388
<u>TOWERS</u>	3	\$80	110%	\$88
<u>INTERNALS</u>		\$16		
<u>REACTORS</u>	3	\$2,100	60%	\$1,260
<u>EXCHANGERS</u>	8	\$84	120%	\$101
<u>AIR COOLERS</u>	2	\$116	90%	\$104
<u>VESSELS</u>	16	\$266	100%	\$266
<u>TANKS</u>				
<u>FILTERS</u>				
<u>PUMPS</u>	30	\$900	100%	\$900
<u>COMPRESSORS</u>	4	\$1,700	60%	\$1,020
<u>PACKAGE UNITS</u>	4	\$45	60%	\$27
<u>TOTAL</u>	72	\$5,792		\$4,154

SUMMARY

<u>EQUIPMENT</u>	\$5,792
<u>COMMODITIES</u>	\$4,154
<u>LABOR</u>	\$3,072 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$3,072 (100% LABOR)
<u>ENGINEERING</u>	<u>\$4,320</u> (1000/PC X \$60)
<u>SUBTOTAL</u>	\$20,410
<u>CONTINGENCY</u>	<u>\$4,082</u> (20%)
<u>TOTAL</u>	\$24,492
<u>PSA</u>	<u>\$1,500</u> PSA 5MM X 1.5 TIC
<u>TOTAL</u>	\$25,992

AREA 200

LCI PROJECT 5571
TASK 4.0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571
PAGE:1
DATE/BY: 21-Apr-89
03:36 PM

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>	2	\$370	60%	\$222
<u>TOWERS</u>	3	\$81	110%	\$89
<u>INTERNALS</u>		\$19		
<u>REACTORS</u>	1	\$900	70%	\$630
<u>EXCHANGERS</u>	10	\$376	90%	\$338
<u>AIR COOLERS</u>	2	\$88	90%	\$79
<u>VESSELS</u>	9	\$266	100%	\$266
<u>TANKS</u>				
<u>FILTERS</u>				
<u>PUMPS</u>	12	\$315	100%	\$315
<u>COMPRESSORS</u>	6	\$5,100	60%	\$3,060
<u>PACKAGE UNITS</u>				
<u>TOTAL</u>	45	\$7,515		\$5,000

SUMMARY

<u>EQUIPMENT</u>	\$7,515
<u>COMMODITIES</u>	\$5,000
<u>LABOR</u>	\$3,751 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$3,751 (100% LABOR)
<u>ENGINEERING</u>	<u>\$2,700</u> (1000/PC X \$60)
<u>SUBTOTAL</u>	\$22,717
<u>CONTINGENCY</u>	<u>\$4,543</u> (20%)
<u>TOTAL</u>	\$27,261
<u>PSA</u>	<u>\$7,500</u> PSA 5MM X 1.5 TIC
<u>TOTAL</u>	\$34,761

AREA 300

LCI PROJECT 5571
TASK 4 0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571
PAGE:1
DATE/BY: 21-Apr-89
03:05 PM

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>	1	\$60	100%	\$60
<u>TOWERS</u>			110%	
<u>INTERNALS</u>				
<u>REACTORS</u>	1	\$560	70%	\$392
<u>EXCHANGERS</u>	2	\$85	100%	\$85
<u>AIR COOLERS</u>	1	\$70	100%	\$70
<u>VESSELS</u>	3	\$85	120%	\$102
<u>TANKS</u>				
<u>FILTERS</u>				
<u>PUMPS</u>	2	\$100	100%	\$100
<u>COMPRESSORS</u>	2	\$400	80%	\$320
<u>PACKAGE UNITS</u>				
<u>TOTAL</u>	12	\$1,360		\$1,129

SUMMARY

<u>EQUIPMENT</u>	\$1,360
<u>COMMODITIES</u>	\$1,129
<u>LABOR</u>	\$813 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$813 (100% LABOR)
<u>ENGINEERING</u>	<u>\$720</u> (1000/PC X \$60)
<u>SUBTOTAL</u>	\$4,836
<u>CONTINGENCY</u>	<u>\$967</u> (20%)
<u>TOTAL</u>	\$5,803

AREA 400

LCI PROJECT 5571
TASK 4.0

OSBL ESTIMATE

PIPING

<u>600 TONS X 1.1 FOR FITTINGS & FLANGES X \$200/TON</u>	\$1,320,000
<u>2000 GALV. @ \$25/FT</u>	\$50,000
<u>LABOR @ .6 HRS/FT. X \$55/HR (80000 FT)</u>	\$2,640,000
<u>TRACING 16200 LF @ \$20/FT</u>	\$324,000

INSULATION

<u>FROM BACK UP</u>	\$420,000
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PIPERACK

<u>3000LF @ \$300/FT</u>	\$900,000
<u>CONCRETE 1500 Y3 X \$350/</u>	\$525,000

<u>TOTAL INTERCONNECTIONS</u>	\$6,179,000
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<u>EQUIPMENT</u>	\$1,846,000
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<u>INSTALLATION MATERIALS FOR EQUIPMENT @ 25%</u>	\$461,500
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<u>LABOR FOR EQUIPMENT & MATERIALS</u>	\$461,500
--	-----------

<u>S/T</u>	\$8,948,000
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<u>ENGINEERING @ 10 %</u>	\$900,000
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<u>S/T</u>	\$9,848,000
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<u>CONTINGENCY @ 30%</u>	\$2,954,400
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<u>TOTAL</u>	\$12,802,400
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AREA 500

LCI PROJECT 5571
TASK 4.0

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

HEATERS				
TOWERS				
INTERNALS				
REACTORS				
EXCHANGERS				
AIR COOLERS				
VESSELS	4	\$105	120%	\$126
TANKS				
FILTERS				
PUMPS	4	\$48	120%	\$58
COMPRESSORS				
PACKAGE UNITS				
TOTAL	8	\$153		\$184

SUMMARY

<u>EQUIPMENT</u>	\$153	
<u>COMMODITIES</u>	\$184	
<u>LABOR</u>	\$125	(10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$125	(100% LABOR)
<u>ENGINEERING</u>	\$480	(1000/PC X \$60)
<u>SUBTOTAL</u>	\$1,068	
<u>CONTINGENCY</u>	\$214	(20%)
<u>TOTAL</u>	\$1,281	
<u>ESCALATION</u>	\$128	10%
<u>TOTAL</u>	\$1,409	

AREA 600

LCI PROJECT 5571
TASK 4.0

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>				
<u>TOWERS</u>	2	\$48	140%	\$67
<u>INTERNALS</u>		\$8		
<u>REACTORS</u>				
<u>EXCHANGERS</u>	1	\$125	85%	\$106
<u>AIR COOLERS</u>				
<u>VESSELS</u>	9	\$123	100%	\$123
<u>TANKS</u>	7	\$89	100%	\$89
<u>FILTERS</u>				
<u>PUMPS</u>	16	\$68	100%	\$68
<u>COMPRESSORS</u>	4	\$230	60%	\$138
<u>PACKAGE UNITS</u>				
<u>TOTAL</u>	39	\$691		\$591

SUMMARY

<u>EQUIPMENT</u>	\$691	
<u>COMMODITIES</u>	\$591	
<u>LABOR</u>	\$424	(10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$424	(100% LABOR)
<u>ENGINEERING</u>	<u>\$1,872</u>	(800/PC X \$60)
<u>SUBTOTAL</u>	\$4,002	
<u>CONTINGENCY</u>	<u>\$800</u>	(20%)
<u>TOTAL</u>	\$4,803	
<u>ESCALATION</u>	<u>\$600</u>	12.5%
<u>TOTAL</u>	\$5,403	

AREA 700

LCI PROJECT 5571
TASK 4.0

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>				
<u>TOWERS</u>	10	\$350	140%	\$490
<u>INTERNALS</u>		\$66		
<u>REACTORS</u>				
<u>EXCHANGERS</u>	20	\$113	100%	\$113
<u>AIR COOLERS</u>				
<u>VESSELS</u>	9	\$65	120%	\$78
<u>TANKS</u>	7	\$117	100%	\$117
<u>FILTERS</u>				
<u>PUMPS</u>	44	\$180	120%	\$216
<u>COMPRESSORS</u>			60%	
<u>PACKAGE UNITS</u>	3	\$20	100%	\$20
<u>TOTAL</u>	93	\$911		\$1,034

SUMMARY

<u>EQUIPMENT</u>	\$911	
<u>COMMODITIES</u>	\$1,034	
<u>LABOR</u>	\$712	(10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$712	(100% LABOR)
<u>ENGINEERING</u>	<u>\$4,464</u>	(800/PC X \$60)
<u>SUBTOTAL</u>	\$7,832	
<u>CONTINGENCY</u>	<u>\$1,566</u>	(20%)
<u>TOTAL</u>	\$9,398	
<u>ESCALATION</u>	<u>\$940</u>	10.0%
<u>TOTAL</u>	\$10,338	

AREA 800

LCI PROJECT 5571
TASK 4.0

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>				
<u>TOWERS</u>	5	\$776	100%	\$776
<u>INTERNALS</u>		\$143	0%	\$0
<u>REACTORS</u>			90%	\$0
<u>EXCHANGERS</u>	14	\$332	100%	\$332
<u>VESSELS</u>	9	\$73	120%	\$88
<u>TANKS</u>	3	\$53	80%	\$42
<u>FILTERS</u>				\$0
<u>PUMPS</u>	52	\$440	100%	\$440
<u>COMPRESSORS</u>				
<u>PACKAGE UNITS</u>	7	\$165	70%	\$115
<u>TOTAL</u>	90	\$1,982		\$1,794

SUMMARY

<u>EQUIPMENT</u>	\$1,982
<u>COMMODITIES</u>	\$1,794
<u>LABOR</u>	\$1,274 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$1,274 (100% LABOR)
<u>ENGINEERING</u>	<u>\$3,600</u> (800/PC X \$50)
<u>SUBTOTAL</u>	\$9,924
<u>CONTINGENCY</u>	<u>\$1,985</u> (20%)
<u>TOTAL</u>	\$11,909

AREA 850

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>				
<u>TOWERS</u>	4	\$115	100%	\$115
<u>INTERNALS</u>		\$281		
<u>REACTORS</u>				
<u>EXCHANGERS</u>	11	\$167	120%	\$200
<u>VESSELS</u>	9	\$25	120%	\$30
<u>TANKS</u>	3	\$127	80%	\$102
<u>FILTERS</u>				
<u>PUMPS</u>	23	\$173	110%	\$190
<u>COMPRESSORS</u>				
<u>PACKAGE UNITS</u>				
<u>TOTAL</u>	50	\$888		\$637

SUMMARY

<u>EQUIPMENT</u>	\$888
<u>COMMODITIES</u>	\$637
<u>LABOR</u>	\$471 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$471 (100% LABOR)
<u>ENGINEERING</u>	<u>\$2,000 (800/PC X \$50)</u>
<u>SUBTOTAL</u>	\$4,468
<u>CONTINGENCY</u>	<u>\$894 (20%)</u>
<u>TOTAL</u>	\$5,361

AREA 900

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>				
<u>TOWERS</u>	5	\$453	100%	\$453
<u>INTERNALS</u>		\$218		
<u>REACTORS</u>				
<u>EXCHANGERS</u>	16	\$220	110%	\$242
<u>VESSELS</u>	4	\$19	120%	\$23
<u>TANKS</u>	6	\$69	80%	\$55
<u>FILTERS</u>				
<u>PUMPS</u>	28	\$210	110%	\$231
<u>COMPRESSORS</u>	2	\$50	110%	\$55
<u>PACKAGE UNITS</u>				
<u>TOTAL</u>	61	\$1,239		\$1,059

SUMMARY

<u>EQUIPMENT</u>	\$1,239
<u>COMMODITIES</u>	\$1,059
<u>LABOR</u>	\$759 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$759 (100% LABOR)
<u>ENGINEERING</u>	<u>\$2,440</u> (800/PC X \$50)
<u>SUBTOTAL</u>	\$6,257
<u>CONTINGENCY</u>	<u>\$1,251</u> (20%)
<u>TOTAL</u>	\$7,508

4.0 OPERATING COSTS

4.1 Operating Labor

It is estimated that it will require 17 men/shift to operate the plant broken down as follows:

Foreman	2
Control Room	2
HDT Operator	2
HDS & JP-8 Operator	2
HCR Operator	1
Naph. Distill. & HDT Operator	2
ARU	2
Phenol Extraction	1
Cresylic Acid Extraction	1
Cresylic Acid Distillation	1
Relief Man	1
Shift Positions	<u>17</u>

Maintenance will be integrated with the existing SNG Plant Maintenance Shop. The existing maintenance department will most likely be expanded by about 10 people.

The total additional people (assuming 6 & 2 operation for the process units) are as follows:

Shift Personnel	17 Positions	X	4	
	People/Position	=	68	
Supervisor & Admin.			6	
QC Technician			2	
Maintenance			10	
Other (Stores or Janitorial)			1	
Total			<u>87</u>	

4.2 Utilities

The following utility requirements have been developed:

<u>UTILITY</u>	<u>CONSUMPTION</u>	<u>COST</u>	<u>\$/CD</u>
#6 Fuel Oil	3904 BPCD	\$16/BBL (a)	62464
SNG Equivalent of SYN Gas & Purge Gas	3.76 MMSCFD	\$3.80/MM BTU (b)	14000
Cooling Water	8063 GPM	\$0.155/MGAL (c)	1800
Power	7230 KW	\$0.04/KWH (c)	6940
Process Water	90 GPM	\$0.45/MGAL (c)	58
HP Steam (550#)	63700 #/H	\$5/M LBS. (c)	7644
MP Steam (100#)	31400 #/H	\$2.50/MLBS (c)	1884
LP Steam (40#)	(13732 #/H)	\$2.50/MLBS (c)	(824)
BFW	11800 #/H	\$2.66/MGAL (c)	91
Condensate Return	(92360 #/H)	\$1.87/MGAL (c)	(495)

(a) Cost of 1% sulfur #6 oil in Minnesota on 11/24/87 as per Platts Oilgram.

(b) Memo from D. Daley of Burns & Roe to L. Lorenzo of DOE dated October 20, 1987 reference DPD-87-863.

(c) ANG utility cost information dated 5/87.

4.2 Utilities - cont'd

4.3 Catalyst & Chemicals

The catalyst and chemicals cost is as follows:

<u>Catalyst & Chem.</u>	<u>Use</u>	<u>Cost</u>	<u>\$/CD</u>
Nap. HDT Cat.	0.021 #/Bbl	\$3.00/#	30
HDT Cat.	0.2 #/Bbl	\$3.00/#	1671
HDS Cat.	0.038 #/Bbl	\$3.30/#	368
HCR Cat.	0.053 #/Bbl	\$6.00/#	491
Inhibitors	50 PPM	\$10/Gal.	60
ARU Solvent	24 #/D	\$2.10/#	60
H ₂ SO ₄	2650 #/D	\$0.04/#	106
			<u>2786</u>

4.4 Maintenance Supplies

Maintenance supplies for hydrotreating operations typically cost between 1.5-2.0% of the installed cost per year. For a daily cost we would estimate the cost of maintenance supplies to be 0.005% of the total installed cost of the process units (excluding the ARU solvent inventory). On this basis the maintenance supplies would be:

$$\frac{0.02}{365} (121,287,000) (0.91) = \$6048/CD.$$

APPENDIX E

LCI Report on "Profitable JP-8" Design:
Plot Plan and Tie-ins

5.0 PLOT PLAN AND UNIT TIE-INS

5.1 Plot Plan

The process units required for the production of JP-8 and by-product chemicals are proposed to be located to the east of the Rectisol Unit of the existing gasification plant as indicated on the markup of the overall Process Area Plot Plan, LCI Dwg E7102-00010A. This area approximately 400 x 600' will be surrounded by an access road and will be divided by two central east-west roads. Areas 100, 200 and 300 will be located to the north and Areas 800, 850 and 900 south of Area 100, and then Areas 600 and 700. The 500 Area equipment is located within Area 100. Adjacent to the 700 Area is a intermediate storage tank area that is utilized with the blocked operation of Area 900 Cresylic Acid Distillation.

A diked storage tank area approximately 375' x 425' will be required for product and fuel oil storage and is proposed to be located to the south of the existing tankage area adjacent to the railcar loading spurs.

5.2 Unit Tie-Ins

Approximately 3000 ft of new interconnecting pipe rack will be required to connect the new process area with the main yard rack of the gasification plant, the product storage area and flare.

New storm, oily water and sanitary sewer lines will be run from the new process units south to their respective collection systems.

A summary of the interconnecting lines is shown in Table 5.1.

TABLE 5.1
INTERCONNECTING PIPING

I. TAR OIL STREAM

<u>EST. SIZE</u>	<u>SERVICE</u>	<u>TO/FROM</u>
4"	Tar/Tar Oil (Elec. Tr.)	Storage
3"	JP-8 Product	Storage
2"	Stabil. Naph. Product	Storage
8"	Synthesis Gas	PSA/Rectisol
6"	Purge Gas	Methanation/PSA
2"	Waste Water	Phosam/HDT, HDC
1 1/2"	300°F Lt. Ends	Storage
1 1/2"	Vac. Twr. Btms. & Slop	Fuel
4"	Off Gas	Fuel Gas
3"	Off Gas	LP. Fuel.

TABLE 5.1 - cont'd

INTERCONNECTING PIPING

II. NAPHTHA STREAM

<u>EST. SIZE</u>	<u>SERVICE</u>	<u>TO/FROM</u>
1 1/2"	Crude Naphtha	Storage
1 1/2"	160°F - Distillate	Storage/Dist.
1 1/2"	Blending Stock	Storage/ARU
1 1/2"	Benzene	Storage/ARU
1 1/2"	Toluene	Storage/ARU
1 1/2"	Xylene	Storage/ARU
1 1/2"	Butane	Storage
3"	Gasoline	Storage
3"	Purge Gas	Fuel Gas/PSA & HDT
1 1/2"	Off Gas	Rectisol/HDT
2"	Waste Water	Phosam/HDT

LCI PROJECT 5571
TASK 4.0

TABLE 5.1

INTERCONNECTING PIPING

III. PHENOL STREAM

EST. SIZE	SERVICE	TO/FROM
2"	Crude Phenol (Elec. Tr.)	Storage
2"	Tar Product	Storage
3"	Phenol Product (Elec. Tr.)	Storage
2"	Crude Cresylic Acid (Elec. Tr.)	Int. Storage & Return
2"	Crude O-Cresol (Elec. Tr.)	Int. Storage & Return
1 1/2"	Crude Xylenol (Elec. Tr.)	Int. Storage & Return
1 1/2"	Crude Cresylic Acid (Elec. Tr.)	Int. Storage & Return
1 1/2"	Slop (Elec. Tr.)	Int. Storage & Return
1 1/2"	Extraction Purge	Fuel/Ph. Ext.
1 1/2"	O-Cresol (Elec. Tr.)	Storage
3"	M,P-Cresol (Elec. Tr.)	Storage
1 1/2"	2,4/2,5 Xylenol Product (Elec. Tr.)	Storage
1 1/2"	Mixed Xylenol Prod. (Elec. Tr.)	Storage
1 1/2"	Methanol Make-Up	Ph. Ext./MeOH Unit
1 1/2"	Sulfuric Acid (Elec. Tr.)	Ph. Ext./Storage
3"	Wash Water (Elec. Tr.)	Treatment/Ph. Ext.
1 1/2"	Waste Water (Elec. Tr.)	Phenosolvan/Ph. Ext.
2"	Off Gas	LP Fuel Gas

IV. COLUMN LINES

EST. SIZE	SERVICE	TO/FROM
30"	Wet Flare (Trace)	Flare
3"	Nitrogen	Main Rack
3"	Plant Air	Main Rack
3"	Instr. Air	Main Rack
2"	Raw Water (Elec. Trace)	Main Rack
8"	HP Steam	Main Rack
8"	MP Steam	Main Rack
20"	C. W. Supply and Return	Main Rack
2"	BFW	Main Rack
4"	Cond. Return	Main Rack
1 1/2"	Boiler B.D.	Main Rack
26"	Storm Sewer (8' Deep)	Storm Basin/ Process Units
15"	Oily Water Sewer (8' Deep)	8100/Process Units
6"	Sanitary Sewer (9' Deep)	8400/Process Units
10"	Fire Water	Rins Header
4"	Fuel Oil (Elec. Trace)	Day Tank/Storage

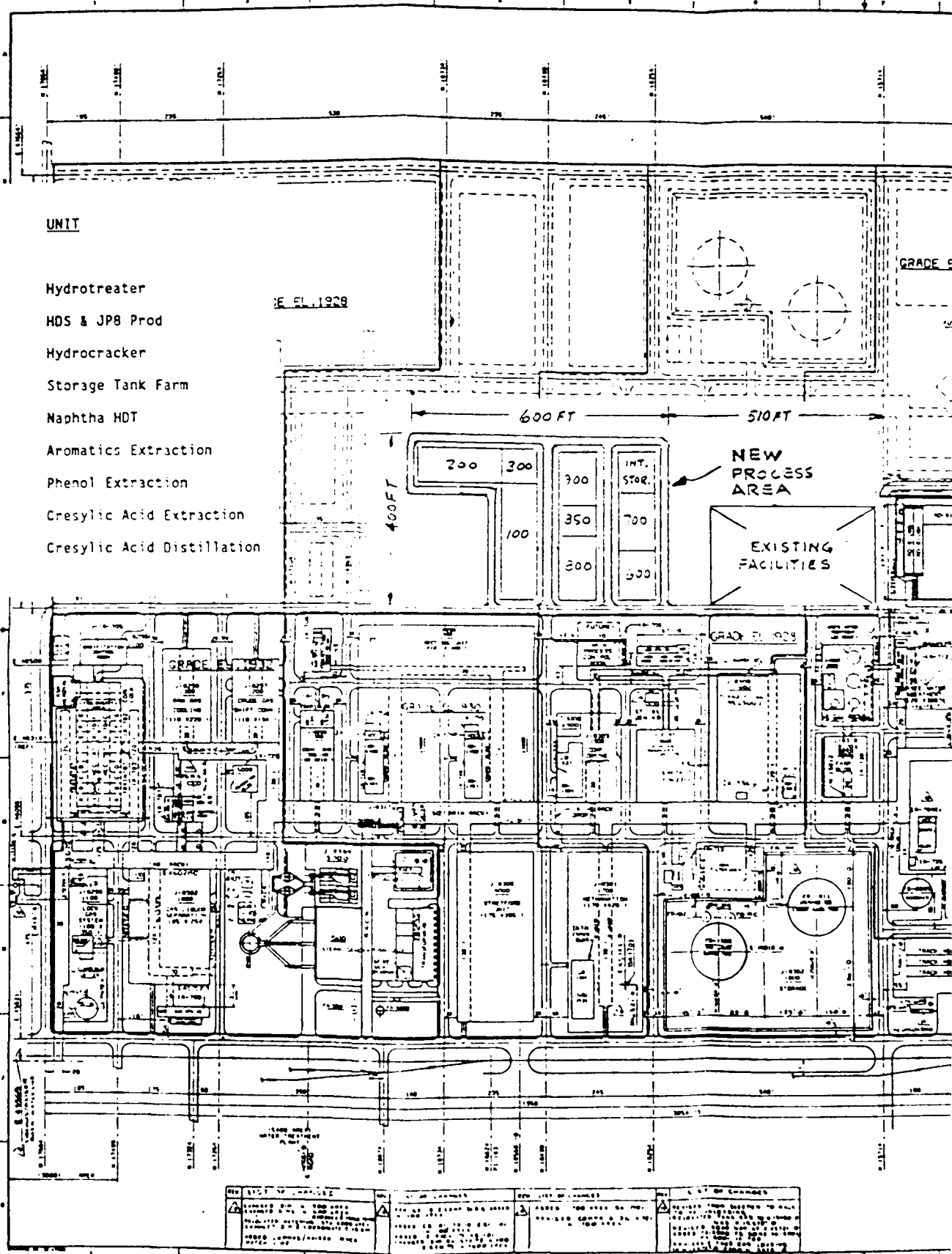
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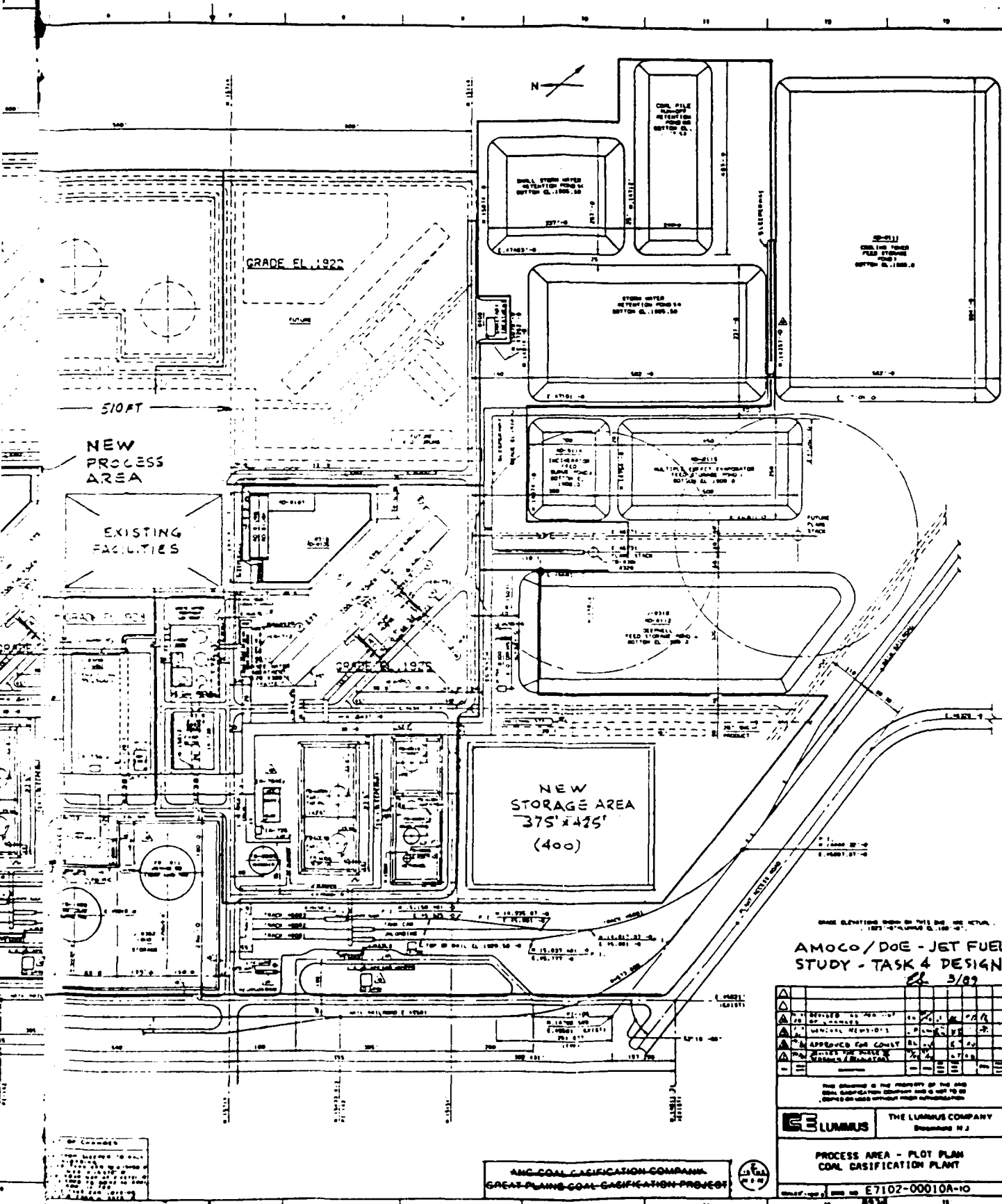
AREA NO.

UNIT

- 100 Hydrotreater
- 200 HDS & JP8 Prod
- 300 Hydrocracker
- 400 Storage Tank Farm
- 600 Naphtha HDT
- 700 Aromatics Extraction
- 800 Phenol Extraction
- 850 Cresylic Acid Extraction
- 900 Cresylic Acid Distillation

E FL 1928





GRADE ELEVATIONS SHOWN ON THIS SHEET ARE ACTUAL
 1987 - 87 LUMMUS E.L. 1000 - 01

**AMOCO/DOE - JET FUEL
 STUDY - TASK 4 DESIGN**
 5/89

APPROVED FOR CONSTRUCTION	DATE	BY	CHKD	APP'D
APPROVED FOR CONSTRUCTION	DATE	BY	CHKD	APP'D
APPROVED FOR CONSTRUCTION	DATE	BY	CHKD	APP'D
APPROVED FOR CONSTRUCTION	DATE	BY	CHKD	APP'D
APPROVED FOR CONSTRUCTION	DATE	BY	CHKD	APP'D

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LUMMUS THE LUMMUS COMPANY
 Broomfield, N.J.

**PROCESS AREA - PLOT PLAN
 COAL GASIFICATION PLANT**
 E7102-00010A-10

**AMC COAL GASIFICATION COMPANY
 GREAT PLAINS COAL GASIFICATION PROJECT**

APPENDIX F

LCI Report on "Profitable JP-8" Design:
Equipment Data and Estimate Sheets

6.0 EQUIPMENT DATA AND ESTIMATE SHEETS

6.1 Tar Oil Stream

6.1.1 AREA 100

6.1.2 AREA 200

6.1.3 AREA 300

6.1.4 AREA 500

AREA 100

LCI PROJECT 5571
TASK 4.0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571

DATE/BY: 21-Apr-89
03:31 PM

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>	2	\$485	80%	\$388
<u>TOWERS</u>	3	\$80	110%	\$88
<u>INTERNALS</u>		\$16		
<u>REACTORS</u>	3	\$2,100	60%	\$1,260
<u>EXCHANGERS</u>	8	\$84	120%	\$101
<u>AIR COOLERS</u>	2	\$116	90%	\$104
<u>VESSELS</u>	16	\$266	100%	\$266
<u>TANKS</u>				
<u>FILTERS</u>				
<u>PUMPS</u>	30	\$900	100%	\$900
<u>COMPRESSORS</u>	4	\$1,700	60%	\$1,020
<u>PACKAGE UNITS</u>	4	\$45	60%	\$27
<u>TOTAL</u>	72	\$5,792		\$4,154

SUMMARY

<u>EQUIPMENT</u>	\$5,792
<u>COMMODITIES</u>	\$4,154
<u>LABOR</u>	\$3,072 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$3,072 (100% LABOR)
<u>ENGINEERING</u>	<u>\$4,320</u> (1000/PC X \$60)
<u>SUBTOTAL</u>	\$20,410
<u>CONTINGENCY</u>	<u>\$4,082</u> (20%)
<u>TOTAL</u>	\$24,492
<u>PSA</u>	<u>\$1,500</u> PSA 5MM X 1.5 TIC
<u>TOTAL</u>	\$25,992

AREA 100

THE LUMMUS COMPANY Bloomfield		ESTIMATE SHEET		QUANTITY		UNIT COST		MATERIAL COST		STD LABOR MH		SUBCONTRACT COST	
DESCRIPTION		REQ	EA	UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST						
1	BA-101 FRESH FEED HEATER (LIQUID ONLY)	1											
2	ABSORBED DUTY												
3	MM Btu/h												
4	W												
5	DES PRESS												
6	DES TEMP												
7	MAT TUBES												
8	TYPE												
9													
10	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>												
11	BA-102 FEED HEATER (MIXED PHASE)	1											
12	ABSORBED DUTY												
13	MM Btu/h												
14	W												
15	DES PRESS												
16	DES TEMP												
17	MAT TUBES												
18	TYPE												
19													
20	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>												
21	BA												
22	ABSORBED DUTY												
23	MM Btu/h												
24	W												
25	DES PRESS												
26	DES TEMP												
27	MAT TUBES												
28	TYPE												
29													
30	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>												
TOTAL THIS PAGE													
TOTAL ACCOUNT													
CLIENT AMOCO/DUC - GREAT PLAINS GASIF. PLANT													
LOCATION BEULAH, NORTH DAKOTA													
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS													
BY 95													
DATE 2/15/89													
REV. 1													
JOB NO. 5571													
ACCT RA													

AREA 100

LUMMUS		ESTIMATE SHEET		THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL
1	DA-101 PREFLASH TOWER						
2	3'-0" ID 55'-0" TT TK SKIRT HT						
3	3'-0" ID (3'-0" x 39' + 15' x 5'-0")	1	11000 LBS	2-	22 000		
4	MAT CS CLAD LINING CA 1/8"						
5	DES PRESS 75 PSIG DES TEMP 550 OF						
6	DES PRESS 75 PSIG DES TEMP 550 OF						
7	X RAY SPOT 100% STRESS REL FAB SHOP FIELD						
8	INTERNAL TRAYS INSTALLED SHOP FIELD 18 VALVE TRAYS						
9							
10	INSUL DA DB 10x DB 10x ERECT WT						
11	DA 102 ATMOSPHERIC TOWER						
12	3'-0" ID 53'-0" TT TK SKIRT HT	1	11000 LBS	3-	33 000		
13	3'-0" ID						
14	MAT CS + 11/32 6' BELT CLAD LINING CA 1/4"						
15	DES PRESS 75 PSIG DES TEMP 460 OF						
16	DES PRESS 75 PSIG DES TEMP 460 OF						
17	X RAY SPOT 100% STRESS REL FAB SHOP FIELD						
18	INTERNAL TRAYS INSTALLED SHOP FIELD 20 VALVE TRAYS						
19							
20	INSUL DA DB 10x DB 10x ERECT WT						
21	DA-103 VACUUM TOWER						
22	3'-6" ID 20'-0" TT TK SKIRT HT	1	7000 LBS	3-	25 000		
23	3'-6" ID						
24	MAT CS + 11/32 CLAD LINING CA						
25	DES PRESS 75 PSIG DES TEMP 800 OF						
26	DES PRESS 75 PSIG DES TEMP 800 OF						
27	X RAY SPOT 100% STRESS REL FAB SHOP FIELD						
28	INTERNAL TRAYS INSTALLED SHOP FIELD 20 VALVE TRAYS						
29							
30	INSUL DA DB 10x DB 10x ERECT WT						
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT AMOCO/POG-GREAT PLAINS GASIF. PLANT		PROD FACT	WAGE RATE	LOC MH	LAB COST	BY	ACCT
LOCATION BEULAH, NORTH DAKOTA						DATE 2/11/89	JOB NO. 5571
PROJECT JET FUEL FROM COAD DERIVED 100000						REV 2	DA

AREA 100

LUMMUS		ESTIMATE SHEET		THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY RFO	EA	UNIT COST	MATERIAL COST	STD LABOR MH UNIT	SUBCONTRACT COST
1	DB 101 PREFLASH TOWER TRAYS						
2	TYPE	DIA	DIA m	mm			
3	VALVE (18)	3'-0"			300	5400	
4							
5							
6							
7							
8							
9	OTHER INTERNALS						
10							
11	DB 102 ATMOSPHERIC TOWER TRAYS						
12	TYPE	DIA	DIA m	mm			
13	VALVE (20)	3'-0"			300	6000	
14							
15							
16							
17							
18							
19	OTHER INTERNALS						
20							
21	DB 103 VACUUM TOWER PACKING						
22	TYPE	DIA	DIA m	mm			
23	GLITCHERID (8'-0") 3'-6"				40	3300	
24					400	800	
25							
26							
27							
28							
29	OTHER INTERNALS SUMMER, DISTRIBUTOR						
30							
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT MOCO/DOE GREAT PLAINS GASIF. PLANT							
LOCATION BERULAH, NORTH DAKOTA							
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS							
		PROJ FACT	LOC MH	BY	DATE	JOB NO	ACCT
		WAL DATE	LAB COST	SS	2/15/89	5571	DR



AREA 100

ESTIMATE WORKSHEET

DESCRIPTION	QUANTITY		STD. LABOR MH	LOCATION LABOR COST (1) x (2) x (3)	UNIT COST	MATERIAL COST	SUB. CONTRACT COST	TOTAL COST M + L + S/C
	AMOUNT	MEAS.						
DC-101, 102, 103 HYDROTREATING REACTOR	3	No.						
6'-0" ID 30'-0" T/T	140	lbs. ss.				700		
						X3		
MAT'L 2 1/2" CLAD SS (31702304) CA						2100		
DES PRESS 2500 PSIG DES TEMP 800 OF								
X-RAY X STRESS REL X FAB SHOP/FIELD								
HORIZONTAL								
VERTICAL X								
INTERNAL								
LC-FINER TYPE REACTOR								
INSUL - YES/NO								
ERECT WT -		tons ss						
DC		No.						
ID T/T		lbs. ss						
SKIRT HT								
MAT'L CLAD								
CA								
DES PRESS PSIG DES TEMP OF								
X-RAY STRESS REL FAB SHOP/FIELD								
VERTICAL								
HORIZONTAL								
INTERNAL								
INSUL - YES/NO								
ERECT WT -		tons ss						
TOTAL THIS PAGE								
TOTAL ACCOUNT DC								
CLIENT Amoco/DGE - GREAT PLAINS GASIF. PLANT								
LOCATION BEULAH, NORTH DAKOTA								
PROJECT JET FUEL FROM COAL DELIVERED LIQUIDS								

BY	DATE	REV.	JOB NO.	EST.	ACCT
	2/11/89		5571		DC

A122 0576-5

AREA 100



ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

ITEM	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	TOTAL			UNIT	TOTAL	
1	EA. 101 HYGO CONDENSER/REH EXCHANGER	1						
2	SIZE-IN. D/L mm D/L							
3	NO SHELL/SERV. 1 SO FT/SHELL TOTAL SO FT 80 /SERV		80 SQ FT		5 000			
4	NO SHELL/SERV. m ² /SHELL TOTAL m ² /SERV		m ²					
5	SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm							
6	MAT CS							
7	DES PRESS 75 PSIG / mm ² hgt/m ² 800 PSIG							
8	DES TEMP 625 OF / OC 550 OF / OC							
9	TUBES: DIA GA MIN AV WELDED SMLS EXP JOINT							
10	TUBE ENDS: WELDED NO. TUBES INSUL ERECT WT.		TONS EA					
11	EA. 102 LVGO CONDENSER	1						
12	SIZE-IN. D/L mm D/L							
13	NO SHELL/SERV. 1 SO FT/SHELL TOTAL SO FT 100 /SERV		100 SQ FT		5 000			
14	NO SHELL/SERV. m ² /SHELL TOTAL m ² /SERV		m ²					
15	SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm							
16	MAT CS							
17	DES PRESS 75 PSIG / mm ² hgt/m ² 150 PSIG							
18	DES TEMP 500 OF / OC 150 OF / OC							
19	TUBES: DIA GA MIN AV WELDED SMLS EXP JOINT							
20	TUBE ENDS: WELDED NO. TUBES INSUL ERECT WT.		TONS EA					
21	EA. 103 HOT IP SEP. VAPOR/STEAM GENERATOR	1						
22	SIZE-IN. D/L mm D/L							
23	NO SHELL/SERV. 1 SO FT/SHELL TOTAL SO FT 850 /SERV		850 SQ FT	25	24 000			
24	NO SHELL/SERV. m ² /SHELL TOTAL m ² /SERV		m ²					
25	SHELL SIDE C.A. 118" / mm TUBE SIDE C.A. 1/8" / mm							
26	MAT SS							
27	DES PRESS 800 PSIG / mm ² hgt/m ² 450 PSIG							
28	DES TEMP 650 OF / OC 650 OF / OC							
29	TUBES: DIA GA MIN AV WELDED SMLS EXP JOINT							
30	TUBE ENDS: WELDED NO. TUBES INSUL ERECT WT.		TONS EA					
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO/DDE - GREAT PLAINS GASIF. PLANT		PROD. FACT	LOC. M.H.	BY	JOB NO.	ACCT		
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE	LAB. COST	DATE 2/2/89	EST	EA		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS				REV 2				



THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

AREA 100

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM	SUBCONTRACT COST
REQ	TOTAL	UNIT	TOTAL				
1 EA-104 HOT L.P. VAPOR/BFW EXCHANGER							
2 SIZE IN. D/I		TYPE AEU					
3 NO SHELL/SERV. 1		SO FT/SHELL		220 SO FT	50	11 000	
4 NO SHELL/SERV.		TOTAL m ² /SERV					
5 SHELL SIDE C.A. 10"		TUBE SIDE C.A. 18"					
6 MAT CS							
7 DES PRESS 800 PSIG		450 PSIG					
8 DES TEMP 350 OF		OC					
9 TUBES DIA GA MIN		AV WELDED SMLS EXP JOINT					
10 TUBE ENDS WELDED		INSUL		TONS EA			
11 EA-105 ATM. TOWER REBOILER							
12 SIZE IN. D/I		TYPE AEU					
13 NO SHELL/SERV. 1		SO FT/SHELL		300 SO FT	30	15 000	
14 NO SHELL/SERV.		TOTAL m ² /SERV					
15 SHELL SIDE C.A. 10"		TUBE SIDE C.A. 10"					
16 MAT CS							
17 DES PRESS 75 PSIG		700 PSIG					
18 DES TEMP 460 OF		OC					
19 TUBES DIA GA MIN		AV WELDED SMLS EXP JOINT					
20 TUBE ENDS WELDED		INSUL		TONS EA			
21 EA-106 ATM. TOWER CONDENSER							
22 SIZE IN. D/I		TYPE AEU					
23 NO SHELL/SERV. 1		SO FT/SHELL		350 SO FT	25	9 000	
24 NO SHELL/SERV.		TOTAL m ² /SERV					
25 SHELL SIDE C.A. 10"		TUBE SIDE C.A. 10"					
26 MAT CS							
27 DES PRESS 75 PSIG		150 PSIG					
28 DES TEMP 250 OF		OC					
29 TUBES DIA GA MIN		AV WELDED SMLS EXP JOINT					
30 TUBE ENDS WELDED		INSUL		TONS EA			
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT APIOCO / DDE - GREAT PLAINS GASIF. PLANT				PROD FACT	LOC M/H	BY 55	ACCT 5571
LOCATION ABEULAH, NORTH DAKOTA				WAGE RATE	LAB COST	DATE 2/1/89	EST
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV 1	EA

ESTIMATE SHEET

THE LUMMAUS COMPANY
Bloomfield

DESCRIPTION										QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST	
										REQ	TOTAL			UNIT	TOTAL		
1	EA	107	FUEL GAS COOLER		TYPE DOUBLE P/AS												
2	SIZE-IN	D/I															
3	NO SHELL/SERV.	SO FT/SHELL	TOTAL SO FT		100 /SERV												
4	NO SHELL/SERV.	m ² /SHELL	TOTAL m ²		/SERV												
5	SHELL SIDE C.A.		mm	TUBE SIDE C.A.		mm											
6	MAT	CS															
7	DES PRESS	750 PSIG	h ₂ O	150 PSIG													
8	DES TEMP	300 OF	OC	150 OF													
9	TUBES: DIA	GA MIN	AV	WELDED	SMLS	EXP JOINT											
10	TUBE ENDS: WELDED		NO TUBES	INSUL	ERECT WT												
11	EA	108	RECYCLE COMPRESSOR CIRCULATION COOLER		TYPE AEU												
12	SIZE-IN	D/I															
13	NO SHELL/SERV.	SO FT/SHELL	TOTAL SO FT		320 /SERV												
14	NO SHELL/SERV.	m ² /SHELL	TOTAL m ²		/SERV												
15	SHELL SIDE C.A.		mm	TUBE SIDE C.A.		mm											
16	MAT	CS															
17	DES PRESS	150 PSIG	h ₂ O	2500 PSIG													
18	DES TEMP	150 OF	OC	320 OF													
19	TUBES: DIA	GA MIN	AV	WELDED	SMLS	EXP JOINT											
20	TUBE ENDS: WELDED		NO TUBES	INSUL	ERECT WT												
21	EA																
22	SIZE-IN	D/I															
23	NO SHELL/SERV.	SO FT/SHELL	TOTAL SO FT		/SERV												
24	NO SHELL/SERV.	m ² /SHELL	TOTAL m ²		/SERV												
25	SHELL SIDE C.A.		mm	TUBE SIDE C.A.		mm											
26	MAT																
27	DES PRESS	PSIG	h ₂ O	PSIG													
28	DES TEMP	OF	OC	OF													
29	TUBES: DIA	GA MIN	AV	WELDED	SMLS	EXP JOINT											
30	TUBE ENDS: WELDED		NO TUBES	INSUL	ERECT WT												
TOTAL THIS PAGE																	
TOTAL ACCOUNT																	
CLIENT API CO, DODE - GREAT PLAINS GASIE PLANT										PROD FACT		LOC MM		BY		JOB NO. 5571	
LOCATION BEULAH, NORTH DAKOTA										WAGE RATE				DATE 2-21-89		EST	
PROJECT FUEL FROM LOCAL TERMINAL														REV 2		EA	

AREA 100



LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST
REQ	TOTAL	REQ	TOTAL			UNIT	
1	EC-102 RECYCLE GAS COOLER						
2	TOTAL BARE SURF		2800	SO FTEA			
3	TOTAL BARE SURF			m ² EA	35		98000
4	TUBE MAT CS						
5	TUBE MAT CS						
6	DES PRESS 450						
7	DES PRESS						
8	NO. FANS TWO EA/HP 20						
9	KNOCK DOWN/PREASSEMBLED						
10	INSUL						
11	EC-102 PREFLASH TOWER CONDENSER						
12	TOTAL BARE SURF		720	SO FTEA	25		18000
13	TOTAL BARE SURF			m ² EA			
14	TUBE MAT						
15	TUBE MAT						
16	DES PRESS 75						
17	DES PRESS						
18	NO. FANS ONE EA/HP 10						
19	KNOCK DOWN/PREASSEMBLED						
20	INSUL						
21	EC						
22	TOTAL BARE SURF			SO FTEA			
23	TOTAL BARE SURF			m ² EA			
24	TUBE MAT						
25	TUBE MAT						
26	DES PRESS						
27	DES PRESS						
28	NO. FANS EA/HP						
29	KNOCK DOWN/PREASSEMBLED						
30	INSUL						
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT		PROJ FACT	LOC. MH	LAB. COST	BY	JOB NO. 5571	ACCT
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE			DATE 2-21-89	EST	EC
PROJECT JET FUEL FROM CRUDE OIL LIQUIDS					REV 2		

APPROVED BY

W

AREA 100



THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

ITEM	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	FA 101 FEED SURGE DRUM							
2	5'-6" ID 20'-6" TT TK SKIRT HT	1						
3	mm							
4	MAT C S CLAD LING CA 1/4" mm							
5	DES PRESS 75 PSIG DES TEMP 300 OF							
6	DES PRESS 100% STRESS REL FAB SHOP FIELD							
7	INTERNAL: VORTEX BREAKER							
8	INSUL HORIZ VERT SPHERE ERECT WT							
9	FA 102 HOT HP SEPARATOR							
10	3'-6" ID 10'-6" TT TK SKIRT HT	1						
11	mm							
12	MAT 2 1/2 Cr - 1 Mo CLAD LING CA mm							
13	DES PRESS 2500 PSIG DES TEMP 800 OF							
14	DES PRESS 100% STRESS REL FAB SHOP FIELD							
15	INTERNAL:							
16	INSUL HORIZ VERT SPHERE ERECT WT							
17	FA 103 HOT LP SEPARATOR							
18	3'-6" ID 9'-0" TT TK SKIRT HT	1						
19	mm							
20	MAT 1 1/2 Cr 1/2 Mo CLAD LING CA mm							
21	DES PRESS 450 PSIG DES TEMP 800 OF							
22	DES PRESS 100% STRESS REL FAB SHOP FIELD							
23	INTERNAL:							
24	INSUL HORIZ VERT SPHERE ERECT WT							
25	FA 104 HOT LP SEPARATOR							
26	3'-6" ID 9'-0" TT TK SKIRT HT	1						
27	mm							
28	MAT 1 1/2 Cr 1/2 Mo CLAD LING CA mm							
29	DES PRESS 450 PSIG DES TEMP 800 OF							
30	DES PRESS 100% STRESS REL FAB SHOP FIELD							
31	INTERNAL:							
32	INSUL HORIZ VERT SPHERE ERECT WT							
33	TOTAL THIS PAGE							
34	TOTAL ACCOUNT							

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT	BY GS	JOB NO. 5571	ACCT
LOCATION BEULAH, NORTH DAKOTA	DATE 2/2/89	EST	FA
PROJECT/TET FUEL FROM COAL DERIVED LIQUIDS	REV 2		

AREA 100

LUMMUS		ESTIMATE SHEET				THE LUMMUS COMPANY Bloomfield			
ITEM	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST	
		REQ	EA			UNIT	TOTAL		
1	FA-104 INTERM. LP SEPARATOR								
2	3'-6" ID 11'-0" TT	1	6000 LBS	3-	18 000				
3	mm								
4	MAT CS (SR) CLAD Lining CA 1/4"								
5	DES PRESS 450								
6	DES PRESS 450								
7	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD								
8	INTERNAL								
9									
10	INSUL HORIZ VERT SPHERE								
11	FA-105 COLD LP SEPARATOR	1							
12	6'-0" ID 18'-0" TT		25000 LBS	134	38 000				
13	mm								
14	MAT CS (SR) CLAD Lining CA 1/4"								
15	DES PRESS 450								
16	DES PRESS 450								
17	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD								
18	INTERNAL HIST ELIMINATOR, VORTEX BREAKER								
19									
20	INSUL HORIZ VERT SPHERE								
21	FA-106 HVGO ACCUMULATOR	1							
22	2'-6" ID 8'-0" TT		1500 LBS	3-	4 500				
23	mm								
24	MAT CS CLAD Lining CA 1/4"								
25	DES PRESS 75 FV								
26	DES PRESS 75 FV								
27	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD								
28	INTERNAL VORTEX BREAKER								
29									
30	INSUL HORIZ VERT SPHERE								
TOTAL THIS PAGE									
TOTAL ACCOUNT									
CLIENT AMOCO/DGE GREAT PLAINS GASIF. PLANT		PROD FACT		LOC MH		BY GS		ACCT	
LOCATION BEULAH, NORTH DAKOTA		WAGERATE		LAB COST		DATE 2/21/89		5571	
PROJECT NET FUEL FROM COAL DERIVED LIQUIDS						REV 2		FA	

AREA 100

LUMMUS		ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST								
		REQ	EA			UNIT	TOTAL								
1	FA-107 LVGO ACCUMULATOR														
2	24" ID 8'-0" TT	1													
3	CS CLAD Lining CA 1/4"														
4	DES PRESS 75 PSIG DES TEMP 500 OF														
5	DES PRESS 75 PSIG DES TEMP 500 OF														
6	DES PRESS 75 PSIG DES TEMP 500 OF														
7	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD														
8	INTERNAL: VORTEX BREAKER														
9															
10	INSUL HORIZ VERT SPHERE														
11	FA-108 VACUUM HOTWELL														
12	3'-6" ID 12'-0" TT	1													
13	CS CLAD Lining CA 1/4"														
14	DES PRESS 75 PSIG DES TEMP 500 OF														
15	DES PRESS 75 PSIG DES TEMP 500 OF														
16	DES PRESS 75 PSIG DES TEMP 500 OF														
17	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD														
18	INTERNAL: BAFFLE, VORTEX BREAKER, BAROMETRIC														
19	LEGS														
20	INSUL HORIZ VERT SPHERE														
21	FA-109 ATN. TOWER SURGE DRUM														
22	5'-0" ID 12'-0" TT	1													
23	CS CLAD Lining CA 1/4"														
24	DES PRESS 75 PSIG DES TEMP 300 OF														
25	DES PRESS 75 PSIG DES TEMP 300 OF														
26	DES PRESS 75 PSIG DES TEMP 300 OF														
27	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD														
28	INTERNAL:														
29															
30	INSUL HORIZ VERT SPHERE														
TOTAL THIS PAGE															
TOTAL ACCOUNT															
CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. MH.		BY 65		JOB NO. 5571		ACCT FA					
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB. COST		DATE 2/21/89		EST		REV. 1					
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS															

A172 10M1-8 REV. 2

AREA 100

THE LUMMUS COMPANY Bloomfield		ESTIMATE SHEET		QUANTITY		MATERIAL		STD LABOR MH		SUBCONTRACT	
DESCRIPTION		REQ	EA	UNIT COST	MATERIAL COST	UNIT	TOTAL	UNIT	TOTAL	UNIT	COST
1	FA 110 ATM. TOWER OVHD ACCUMULATOR										
2	2'-6" ID 8'-0" TT TK	1									
3	3" <input type="checkbox"/> mm										
4	MAT CS CLAD <input type="checkbox"/> LINING CA 1/4"										
5	DES PRESS 75 PSIG DES TEMP 250 OF										
6	DES PRESS 75 PSIG DES TEMP 250 OF										
7	X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>										
8	INTERNAL VORTEX BREAKER, WATER POT										
9											
10	INSUL <input type="checkbox"/> HORIZ <input checked="" type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>										
11	FA 111 WATER WASH SURGE DRUM										
12	4'-6" ID 11'-0" TT TK	1									
13	3" <input type="checkbox"/> mm										
14	MAT CS CLAD <input type="checkbox"/> LINING CA 1/4"										
15	DES PRESS 150 PSIG DES TEMP 400 OF										
16	DES PRESS 150 PSIG DES TEMP 400 OF										
17	X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>										
18	INTERNAL:										
19											
20	INSUL <input checked="" type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/>										
21	FA 112 WATER SEAL POT										
22	24" OD 5'-0" TT TK	1									
23	3" <input type="checkbox"/> mm										
24	MAT CS CLAD <input type="checkbox"/> LINING CA 1/4"										
25	DES PRESS 75 PSIG DES TEMP 50 OF										
26	DES PRESS 75 PSIG DES TEMP 50 OF										
27	X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>										
28	INTERNAL:										
29											
30	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/>										
TOTAL THIS PAGE											
TOTAL ACCOUNT											
CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT		PROD FACT	LOC M.H.	BY	DATE	REV.	JOB NO.	EST	ACCT		
LOCATION BEULAH NORTH DAKOTA					2/21/89		5571		FA		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS											

A 172 1001 R REV. 2

3

AREA 100

THE LUMMUS COMPANY Bloomfield		ESTIMATE SHEET		QUANTITY		MATERIAL COST		UNIT COST		STD LABOR MH		SUBCONTRACT COST	
DESCRIPTION				REQ	EA					UNIT	TOTAL		
1	FA-113	WATER COLLECTION P&T											
2	18" OD	3'-0"	TK	1									
3	m					1000	LBS	4					
4	MAT	CS	CLAD LING										
5	DES PRESS	75	PSIG										
6	DES PRESS		DES TEMP										
7	X-RAY SPOT	100%	STRESS REL										
8	INTERNAL												
9													
10	INSUL	HORIZ	VERT										
11	FA-114	FUEL GAS K.O. DRUM											
12	2'-6" ID	8'-0"	TK	1									
13	m					2000	LBS	4					
14	MAT	CS	CLAD LING										
15	DES PRESS	350	PSIG										
16	DES PRESS		DES TEMP										
17	X-RAY SPOT	100%	STRESS REL										
18	INTERNAL												
19													
20	INSUL	HORIZ	VERT										
21	FA-115	RECYCLE GAS K.O. DRUM											
22	2'-6" ID	8'-0"	TK	1									
23	m					1500	LBS	4					
24	MAT	CS	CLAD LING										
25	DES PRESS	450	PSIG										
26	DES PRESS		DES TEMP										
27	X-RAY SPOT	100%	STRESS REL										
28	INTERNAL												
29													
30	INSUL	HORIZ	VERT										
TOTAL THIS PAGE													
TOTAL ACCOUNT													
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT				PROD. FACT		LOC. M.H.		BY		JOB NO.		ACCT	
LOCATION BEULAH, NORTH DAKOTA				WAGE RATE		LAB. COST		DATE 2/21/89		EST		FA	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS								REV. 1					

AREA 100

LUMMUS		ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST							
		REQ	EA			UNIT	TOTAL								
1	FA: 116 PREFLASH POWER OVERHEAD ARUN	1													
2	3'-6" ID 9'-0" TT TK SKIRT HT		3000	LBS	4-		12000								
3	3" mm														
4	MAT CS CLAD LINING CA 1/8" mm														
5	DES PRESS 75 PSIG DES TEMP 300 OF														
6	DES PRESS 75 PSIG DES TEMP 300 OF														
7	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD														
8	INTERNALS VORTEX BREAKER														
9															
10	INSUL HORIZ VERT SPHERE ERECT WT			TONS											
11	FA:														
12	10 ID TT TK SKIRT HT			LBS											
13	3" mm														
14	MAT CLAD LINING CA mm														
15	DES PRESS PSIG DES TEMP OF														
16	DES PRESS PSIG DES TEMP OF														
17	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD														
18	INTERNALS														
19															
20	INSUL HORIZ VERT SPHERE ERECT WT			TONS											
21	FA:														
22	10 ID TT TK SKIRT HT			LBS											
23	3" mm														
24	MAT CLAD LINING CA mm														
25	DES PRESS PSIG DES TEMP OF														
26	DES PRESS PSIG DES TEMP OF														
27	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD														
28	INTERNALS														
29															
30	INSUL HORIZ VERT SPHERE ERECT WT			TONS											
TOTAL THIS PAGE															
TOTAL ACCOUNT															
CLIENT AMIGO/DOE - GREAT PLAINS GASIF. PLANT		PROD FACT	LOC. MH	LAB COST	BY	DATE	REV	ACCT							
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE						FA							
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS															

AT 12/10/81 REV 2

AREA 100

LUMMUS		ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST								
		REQ	EA			UNIT	TOTAL								
1	GA 101 A/S FEED	2													
2	GPM 110				150 000										
3	PSIG DISCH														
4	TEMP 150 OF														
5	ΔP														
6	ΔP														
7	DRIVE EM - CS IMPELLER CS 2 1/6 HP														
8	TYPE CENT - RECIP PROP OTHERS API ANSI														
9	MECH SEAL														
10	INSUL														
11	GA 102 A/S LIQUID QUENCH	2													
12	GPM 23				70 000										
13	PSIG DISCH														
14	TEMP 120 OF														
15	ΔP														
16	ΔP														
17	DRIVE EM - CS IMPELLER CS 80 HP														
18	TYPE CENT - RECIP PROP OTHERS API ANSI														
19	MECH SEAL														
20	INSUL														
21	GA 103 A/S HNGO	2													
22	GPM 10				15 000										
23	PSIG DISCH														
24	TEMP 400 OF														
25	ΔP														
26	ΔP														
27	DRIVE EM - CS IMPELLER CS 3 HP														
28	TYPE CENT - RECIP PROP OTHERS API ANSI														
29	MECH SEAL														
30	INSUL														
TOTAL THIS PAGE															
TOTAL ACCOUNT															
CLIENT ALCOA/DOE - GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. M.H.		BY		JOB NO.		ACCT					
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB. COST		DATE 2/24/89		EST		NO. 5571		GA			
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV.		1							

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ESTIMATE SHEET

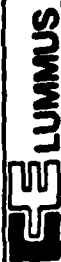
THE LUMMUS COMPANY
Bloomfield

DESCRIPTION										QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
										REQ	EA			UNIT	TOTAL	
1 GA. 104 A/S LVGO										2						
2	GPM	5	SUCT	PSIG	DISCH	PSI	TEMP	120	OF							
3	m ³ /h		SUCT	PSIG	DISCH	PSI	TEMP	120	OF							
4	SP. GR		ΔP	FT	100	PSI	STGS						15 000			
5			ΔP	m		PSI	RPM									
6	MAT. CASE	C.S.	IMPELLER	C.S.												
7	DRIVE EM -	<input checked="" type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER			1.5	HP								
8	TYPE CENT -	<input checked="" type="checkbox"/> RECIP	<input type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	<input type="checkbox"/> API	<input type="checkbox"/> ANSI										
9	MECH. SEAL	<input type="checkbox"/>														
10	INSUL	<input type="checkbox"/>														
11 GA. 105 SLOP O/L										1						
12	GPM	0.2	SUCT	PSIG	DISCH	PSI	TEMP	120	OF							
13	m ³ /h		SUCT	PSIG	DISCH	PSI	TEMP	120	OF							
14	SP. GR		ΔP	FT	70	PSI	STGS						15 000			
15			ΔP	m		PSI	RPM									
16	MAT. CASE	C.S.	IMPELLER	C.S.												
17	DRIVE EM -	<input type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER			0.9	HP								
18	TYPE CENT -	<input type="checkbox"/> RECIP	<input type="checkbox"/> PROP	<input checked="" type="checkbox"/> OTHERS	<input type="checkbox"/> API	<input type="checkbox"/> ANSI										
19	MECH. SEAL	<input type="checkbox"/>														
20	INSUL	<input type="checkbox"/>														
21 GA. 106 1/2 HOUR WATER										2						
22	GPM		SUCT	PSIG	DISCH	PSI	TEMP	120	OF							
23	m ³ /h		SUCT	PSIG	DISCH	PSI	TEMP	120	OF							
24	SP. GR		ΔP	FT	100	PSI	STGS						15 000			
25			ΔP	m		PSI	RPM									
26	MAT. CASE	C.S.	IMPELLER	C.S.												
27	DRIVE EM -	<input type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER			1.5	HP								
28	TYPE CENT -	<input type="checkbox"/> RECIP	<input checked="" type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	<input type="checkbox"/> API	<input type="checkbox"/> ANSI										
29	MECH. SEAL	<input type="checkbox"/>														
30	INSUL	<input type="checkbox"/>														
TOTAL THIS PAGE																
TOTAL ACCOUNT																
CLIENT ALILOGO/DE-GREAT PLAINS GASIF. PLANT																
LOCATION BEULAH, NORTH DAKOTA																
PROJECT JET FUEL FROM COAL RECEIVED LUMMUS																
										BY	65	JOB NO.	5571	ACCT		
										DATE	2/22/89	EST		GA		
										REV	1					

AREA 100

THE LUMMUS COMPANY Bloomfield									
ESTIMATE SHEET									
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST		
		REC	EA			UNIT	TOTAL		
1	GA-107 AS ATTY. TOWER 00H/3	2							
2	GPM 10				15 000				
3	PSIG DISCH								
4	TEMP /LO OF								
5	TEMP								
6	SP-GR								
7	ΔP								
8	ΔP								
9	MAT CASE CS								
10	IMPELLER CS								
11	DRIVE EM - TURB DIESEL OTHER								
12	TYPE CENT - RECIP PROP OTHERS								
13	MECH. SEAL								
14	INSUL								
15	ERECT. WT. PUMP & DRIVER								
16	GA-108 AS VAC. TOWER 80 TONS	2							
17	GPM 3				30 000				
18	PSIG DISCH								
19	TEMP								
20	SP-GR								
21	ΔP								
22	ΔP								
23	MAT CASE 11-13 C								
24	IMPELLER 11-13 C								
25	DRIVE EM - TURB DIESEL OTHER								
26	TYPE CENT - RECIP PROP OTHERS								
27	MECH. SEAL								
28	INSUL								
29	ERECT. WT. PUMP & DRIVER								
30	GA-109 110 & 111 REACTOR RECYCLE (3088)	3							
31	GPM 2800				500 000				
32	PSIG DISCH								
33	TEMP								
34	SP-GR								
35	ΔP								
36	ΔP								
37	MAT CASE SS								
38	IMPELLER SS								
39	DRIVE EM - TURB DIESEL OTHER								
40	TYPE CENT - RECIP PROP OTHERS								
41	MECH. SEAL								
42	INSUL								
43	ERECT. WT. PUMP & DRIVER								
44	TOTAL THIS PAGE								
45	TOTAL ACCOUNT								
46	CLIENT ALCO/Dee-GREAT PLAINS GASIF. PLANT								
47	LOCATION BEULAH, NORTH DAKOTA								
48	PROJECT JET FUEL FROM COAL DERIVED LIQUIDS								
49	BY GS								
50	DATE 2/21/79								
51	REV.								
52	JOB NO. 5571								
53	ACCT GA								

AREA 100



THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL
1	GA-112 A/S WASH WATER	2					
2	GPM 42 SUCT PSIG DISCH TEMP 210 °F				20 000		
3	m³/h SUCT SUCT DISCH TEMP °C						
4	SP GR ΔP FT 350 PSI STGS						
5	ΔP m RPM						
6	MAT CASE CS IMPELLER CS 18 HP						
7	DRIVE EM - TURB DIESEL OTHER						
8	TYPE CENT - RECIP PROP OTHERS API ANSI						
9	MECH SEAL						
10	INSUL ERECT WT. PUMP & DRIVER						
11	GA-113 A/S HAS FEED	2					
12	GPM 137 SUCT PSIG DISCH TEMP 410 °F				20 000		
13	m³/h SUCT SUCT DISCH TEMP °C						
14	SP GR ΔP FT 50 PSI STGS						
15	ΔP m RPM						
16	MAT CASE CS IMPELLER CS 8 HP						
17	DRIVE EM - TURB DIESEL OTHER						
18	TYPE CENT - RECIP PROP OTHERS API ANSI						
19	MECH SEAL						
20	INSUL ERECT WT. PUMP & DRIVER						
21	GA-114 A/S FRESH FEED	2					
22	GPM 110 SUCT PSIG DISCH TEMP 150 °F				20 000		
23	m³/h SUCT SUCT DISCH TEMP °C						
24	SP GR ΔP FT PSI STGS						
25	ΔP m RPM						
26	MAT CASE CS IMPELLER CS 11 HP						
27	DRIVE EM - TURB DIESEL OTHER						
28	TYPE CENT - RECIP PROP OTHERS API ANSI						
29	MECH SEAL						
30	INSUL ERECT WT. PUMP & DRIVER						
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT ALCOA/DOE-GREAT PLAINS GASIF PLANT		BY GS	JOB NO. 5571	ACCT GA			
LOCATION BEULAH, NORTH CAROLINA		DATE 2/2/89	EST				
PROJECT JET FUEL FROM COAL LIQUIFIED LIGNITE		REV 1					

A122 0482.10 REV 3



ESTIMATE SHEET

DESCRIPTION										QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST	
										REQ	EA			UNIT	TOTAL		
1	GA 115 A/S PREFLASH TOWER OVERHEAD										2			15 000			
2	GPM	3 S	SUCT	PSIG	DISCH	PSI	TEMP	200 OF									
3	m ³ /h		SUCT	h ₂ O h ₂ O/m ²	DISCH	h ₂ O h ₂ O/m ²	TEMP	OC									
4	SP GR		ΔP	FT	60	PSI	STGS										
5			ΔP	m		h ₂ O h ₂ O/m ²	RPM										
6	MAT: CASE																
7	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>																
8	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>																
9	MECH SEAL <input type="checkbox"/>																
10	INSUL <input type="checkbox"/>																
11	GA																
12	GPM		SUCT	PSIG	DISCH	PSI	TEMP	OF									
13	m ³ /h		SUCT	h ₂ O h ₂ O/m ²	DISCH	h ₂ O h ₂ O/m ²	TEMP	OC									
14	SP GR		ΔP	FT		PSI	STGS										
15			ΔP	m		h ₂ O h ₂ O/m ²	RPM										
16	MAT: CASE																
17	DRIVE EM - <input type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>																
18	TYPE CENT - <input type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>																
19	MECH SEAL <input type="checkbox"/>																
20	INSUL <input type="checkbox"/>																
21	GA																
22	GPM		SUCT	PSIG	DISCH	PSI	TEMP	OF									
23	m ³ /h		SUCT	h ₂ O h ₂ O/m ²	DISCH	h ₂ O h ₂ O/m ²	TEMP	OC									
24	SP GR		ΔP	FT		PSI	STGS										
25			ΔP	m		h ₂ O h ₂ O/m ²	RPM										
26	MAT: CASE																
27	DRIVE EM - <input type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>																
28	TYPE CENT - <input type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>																
29	MECH SEAL <input type="checkbox"/>																
30	INSUL <input type="checkbox"/>																
TOTAL THIS PAGE																	
TOTAL ACCOUNT																	
CLIENT AMOCO / DOE - GREAT PLAINS GAS/L PLANT															BY	45	JOB NO. 5571
LOCATION BEOLA, NORTH DAKOTA															DATE	3-6-89	EST
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS															REV.	/	GA

AREA 100



ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	GB-101 A/S BECKLE COMPRESSOR PACKAGE	2						
2	CAP. SCFM 7624 STM PSIG/ ^{HP2} _{HP1} P2/P1 212/212				1,400.000			
3	MAT'L HANDLED ~ 97% H ₂ - 3% CH ₄ 2.1 MM							
4	SUCT 295 PSIA/ ^{HP2} _{HP1} TEMP 105 OF STGS 3							
5	DISCH 2300 PSIA/ ^{HP2} _{HP1} CD/CO 1.397							
6	MAT. CASE CS IMPELLER CS VOLTS							
7	DRIVER-EM TURB DIESEL 1805 BHP/ LW							
8	INCL. GEAR LUBE & SEAL INTERCOOLER COND 3 STAGE UNITS							
9	TYPE: CENT RECIP ROTARY SCREW							
10	INSUL ERECT. WT. COMPR + DRIVE TONS							
11	GB-102 A/S FUEL GAS COMPRESSOR	2			300.000			
12	CAP. SCFM 12 667 STM PSIG/ ^{HP2} _{HP1} P2/P1 2.85							
13	MAT'L HANDLED FUEL GAS 18.6 MM							
14	SUCT 15.7 PSIA/ ^{HP2} _{HP1} TEMP 110 OF STGS							
15	DISCH 44.7 PSIA/ ^{HP2} _{HP1} CD/CO 1.25							
16	MAT. CASE CS IMPELLER CS VOLTS							
17	DRIVER EM TURB DIESEL 120 BHP/ LW							
18	INCL. GEAR LUBE & SEAL INTERCOOLER COND							
19	TYPE: CENT RECIP ROTARY SCREW							
20	INSUL ERECT. WT. COMPR + DRIVE TONS							
21	GB-							
22	CAP. SCFM STM PSIG/ ^{HP2} _{HP1} P2/P1							
23	MAT'L HANDLED MM							
24	SUCT PSIA/ ^{HP2} _{HP1} TEMP OF STGS							
25	DISCH PSIA/ ^{HP2} _{HP1} CD/CO STGS							
26	MAT. CASE IMPELLER VOLTS LW							
27	DRIVER EM TURB DIESEL BHP/ LW							
28	INCL. GEAR LUBE & SEAL INTERCOOLER COND							
29	TYPE: CENT RECIP ROTARY SCREW							
30	INSUL ERECT. WT. COMPR + DRIVE TONS							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO/DUE - GREAT PLAINS STATE, OKLAHOMA		P 100 FACT		LOC M H		ACCT		
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB COST		JOB NO. 5571		GB
PROJECT SET FUEL FROM COAL DERIVED Liquefied						DATE 2/21/89		
						REV 2		

AT22 1001 11 REV 2



AREA 100

THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
	REQ	EA			UNIT	TOTAL	
PA-101 VACUUM EJECTOR PACKAGE PROVIDE A MULTISTAGE (TWO OR THREE) VACUUM SYSTEM TO EVACUATE CONTINUOUS OVERHEAD STREAM FROM VACUUM TOWER DA-101. VENDOR TO SUPPLY EJECTORS INTER & AFTER CONDENSERS AS WELL AS INLET AND ISOLATING STEAM VALVES WHOSE SYSTEM TO BE LOCATED INSIDE STRUCTURE 20A-D:	1						
NON-CONDENSABLE AND CONDENSIBLE GASES 68 #/HR MW = 32 ESTIM. AIR LEAKAGE 6 #/HR ESTIMATED DISCH. PRESSURE: 2 PSIG SUCTION PRESSURE: 0.5 PSIA SYSTEM WILL DISCHARGE THROUGH BAROMETRIC LEGS INTO VACUUM HOTWELL (NOT PART OF PACKAGE) INLET (SUCTION) TEMP: 100 °F HOTW. STEAM PRESSURE HP SAT'D: 100 PSIG @ 337 °F COOLING WATER: 82 °F INLET							
PA-102 MS FLAME ARRESTOR. PROVIDE TWO (ONE OPERATING, ONE SPARE) CAPACITY: MAX: 20 #/HR MW ≈ 29 PRESSURE DROP: MAX 2 IN(WATER)	2			5000			
PA-103 CORROSION INHIBITOR PACKAGE (STD.)	1			15000			
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT AMOCO/DOS GREAT PLAINS GASIF. PLANT	PROD FACT	LOC. M.H.	BY	DATE	JOB NO.	EST	ACCT
LOCATION BEULAH, NORTH DAKOTA			GS	2/23/09	5571		
PROJECT OCT FUEL FROM COAL DERIVED LIQUID	WAGE RATE	LAR COST		11V			

AREA 100

LUMMUS		ESTIMATE SHEET				THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST	
		REQ	EA			UNIT	TOTAL		
1	PA-104	1							
2	PSA UNIT								
3	PROVIDE ONE FULLY INSTRUMENTED								
4	AND PIPED (EXCLUDING OFF GAS SURGE DRUM)								
5	SYSTEM FOR THE FOLLOWING GAS								
6	LOAD:								
7	FLOW: 7,756,000 SCFD								
8	MOL WT: 2.72								
9	PRESSURE: 310 PSIG								
10	TEMPERATURE: 110 °F								
11									
12	GAS COMPOSITION								
13	H ₂								
14	H ₂								
15	C ₁								
16	C ₂								
17	C ₃								
18	C ₄								
19	C ₅								
20	C ₆								
21									
22	PRODUCT GAS: 99.9% H ₂ (MIN.)								
23	EXPECTED H ₂ RECOVERY: 86% (MIN.)								
24									
25									
26									
27									
28									
29									
30									
TOTAL THIS PAGE									
TOTAL ACCOUNT									
CLIENT AMOCO/DOW GREAT PLAINS GASIF. PLANT		PROD FACT				BY	JOB NO	ACCT	
LOCATION BEULAH, NORTH DAKOTA		WASTE DATE				DATE 2/23/89	EST	5571	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV 2			

AREA 200

LCI PROJECT 5571
TASK 4.0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571

DATE/BY: 21-Apr-89
 03:36 PM

EQUIPMENT \$ PCS. \$ EQUIP. \$ COMM \$ COMM

<u>HEATERS</u>	2	\$370	60%	\$222
<u>TOWERS</u>	3	\$81	110%	\$89
<u>INTERNALS</u>		\$19		
<u>REACTORS</u>	1	\$900	70%	\$630
<u>EXCHANGERS</u>	10	\$376	90%	\$338
<u>AIR COOLERS</u>	2	\$88	90%	\$79
<u>VESSELS</u>	9	\$266	100%	\$266
<u>TANKS</u>				
<u>FILTERS</u>				
<u>PUMPS</u>	12	\$315	100%	\$315
<u>COMPRESSORS</u>	6	\$5,100	60%	\$3,060
<u>PACKAGE UNITS</u>				
<u>TOTAL</u>	45	\$7,515		\$5,000

SUMMARY

<u>EQUIPMENT</u>	\$7,515
<u>COMMODITIES</u>	\$5,000
<u>LABOR</u>	\$3,751 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$3,751 (100% LABOR)
<u>ENGINEERING</u>	<u>\$2,700</u> (1000/PC X \$60)
<u>SUBTOTAL</u>	\$22,717
<u>CONTINGENCY</u>	<u>\$4,543</u> (20%)
<u>TOTAL</u>	\$27,261
<u>PSA</u>	<u>\$7,500</u> PSA 5MM X 1.5 TIC
<u>TOTAL</u>	\$34,761

AREA 200



ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST
REQ	EA					UNIT	TOTAL
1	BA-201	HDS FEED HEATER ✓					
2	ABSORBED DUTY	RAD	CONV				
3	MM Btu/h						
4	LW						
5	DES PRESS	2900 PSIG					
6	DES TEMP	800 °F (FLUID)	PSIG				
7	MAT TUBES	5 C2 - 1/2 M0	OF				
8	TYPE	CYL. VERTICAL					
9							
10	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>						
11	BA-202	JPB TOWER FEED HEATER ✓					
12	ABSORBED DUTY	RAD	CONV				
13	MM Btu/h	24,000	1.00 (*)		300 000		
14	LW						
15	DES PRESS	150 PSIG	150 PSIG				
16	DES TEMP	750 °F (FLUID)	OC				
17	MAT TUBES	5 C2 - 1/2 M0	CS FOR STEAM COIL				
18	TYPE	CYL. VERTICAL					
19	(a) STEAM SUPERHEATING						
20	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>						
21	BA						
22	ABSORBED DUTY	RAD	CONV				
23	MM Btu/h						
24	LW						
25	DES PRESS	PSIG	PSIG				
26	DES TEMP	°F	OF				
27	MAT TUBES						
28	TYPE						
29							
30	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>						
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT AMOCO/DOE - GRANT PLAINS OILFIELD PLANT		PROD FACT		LOC MH	LAB COST	BY	ACCT
LOCATION REGGIAN, NORTH DAKOTA		WAGE RATE				DATE FEB 1994	EST NO. 5571
PROJECT JET FUEL FROM COAL PROCESSING LIQUIDS						REV	BA

AREA 200

THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

NO	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	DA 201 JPB TOWER ✓							
2	7'-6" ID 50'-0" TT TK 25' SKIRT HT							
3	mm		33000 LBS	170	36000			
4	MAT CS CLAD Lining CA 1/8" / mm							
5	DES PRESS 75 PSIG DES TEMP 730 °F							
6	DES PRESS 100% STRESS REL FAB SHOP FIELD							
7	X RAY SPOT 100% STRESS REL FAB SHOP FIELD							
8	INTERNAL TRAYS-INSTALLED SHOP FIELD 20 VALVE TRAYS		700		14000			
9	410 SS							
10	INSUL DA DB 10% ERECT WT		TONS					
11	DA 202 JPB PRODUCT STRIPPER ✓							
12	3'-0" ID 20'-0" TT TK 25' SKIRT HT		70000 LBS	220	15000			
13	mm							
14	MAT CS CLAD Lining CA 1/8" / mm							
15	DES PRESS 75 PSIG DES TEMP 500 °F							
16	DES PRESS 100% STRESS REL FAB SHOP FIELD							
17	X RAY SPOT 100% STRESS REL FAB SHOP FIELD							
18	INTERNAL TRAYS-INSTALLED SHOP FIELD 6 VALVE TRAYS		300		1800			
19	410 SS							
20	INSUL DA DB 10% ERECT WT		TONS					
21	DA 203 HAPHTHA STABILISER ✓							
22	2'-6" ID 25'-0" TT TK MIN. SKIRT HT		50000 LBS	250	10000			
23	mm							
24	MAT CS CLAD Lining CA 1/8" / mm							
25	DES PRESS 150 PSIG DES TEMP 450 °F							
26	DES PRESS 100% STRESS REL FAB SHOP FIELD							
27	X RAY SPOT 100% STRESS REL FAB SHOP FIELD							
28	INTERNAL TRAYS INSTALLED SHOP FIELD 10 VALVE TRAYS		300		3000			
29	410 SS							
30	INSUL DA DB 10% ERECT WT		TONS					
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMULS/POB-GREAT PLAINS GASIF PLANT		PROD FACT	LOC MH	BY	HHK	JOB NO.	ACCT	
LOCATION DEULAH, NORTH DAKOTA		WAGE RATE	LAB COST	DATE	FEB 1989	5571	DA	
PROJECT TET FOR FILL GUARD DITCH				REV	C			



LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

AREA 200

ITEM NO	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REC'D	FA			UNIT	TOTAL	
1	DC 201 HDS REACTOR ✓							
2	6'-0" ID 30'-0" TT TK MIN SKIRTM	1	260,000	3.15	900,000			
3	m [] mm []							
4	MAT 2 1/4 G ₂ - 1/2 M ₀ CLAD [] LINING []							
5	DES PRESS 2600							
6	DES PRESS							
7	X RAY SPOT [] 100% [] STRESS REL [] FAB SHOP [] FIELD []							
8	INTERNAL TWO(2) - CATALYST BEDS : 8'-0" AND 16'-0" HIGH WITH							
9	CATALYST SUPPORT PLATES : HOLDOWN PLATES							
10	INSUL [] HORIZ [] VERT []							
11	DC							
12	ID TT TK SKIRTM							
13	m [] mm []							
14	MAT CLAD [] LINING []							
15	DES PRESS							
16	DES PRESS							
17	X RAY SPOT [] 100% [] STRESS REL [] FAB SHOP [] FIELD []							
18	INTERNAL							
19	INSUL [] HORIZ [] VERT []							
20	DC							
21	ID TT TK SKIRTM							
22	m [] mm []							
23	MAT CLAD [] LINING []							
24	DES PRESS							
25	DES PRESS							
26	X RAY SPOT [] 100% [] STRESS REL [] FAB SHOP [] FIELD []							
27	INTERNAL							
28	INSUL [] HORIZ [] VERT []							
29								
30								
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT DOE/AMOCO - GREAT PLAINS GASIF PLANT								
LOCATION BEULAH, SOUTHERN DAKOTA								
PROJECT NO. 100-100000000								
REV								
DATE								
JOB NO								
EST								
ACCT								
DC								

AREA 200

THE LUMMUS COMPANY Bloomfield		ESTIMATE SHEET		QUANTITY		MATERIAL COST		STD LABOR MM		SUBCONTRACT COST	
DESCRIPTION		REQ	TOTAL	UNIT COST	MATERIAL COST	UNIT	TOTAL				
1	EA. 201 HDS REACTOR FEED/EFFLUENT EXCHANGER ✓										
2	SIZE IN D/L										
3	NO SHELL/SERV. ONE 30 FT/SHELL 1850 TOTAL SOFT 1850 /SERV										
4	NO SHELL/SERV. TOTAL m ² /SERV		1850 SOFT	125	231		2000				
5	SHELL SIDE C.A. mm										
6	MAT 2 1/4 G ₁ - 1/2 M ₀										
7	DES PRESS 2900 PSIG 2600 PSIG										
8	DES TEMP 750 OF 800 OF										
9	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT										
10	TUBE ENDS WELDED NO. TUBES INSUL ERECT WT										
11	EA. 202 378 TOWER FEED/BOTTOMS EXCHANGER ✓										
12	SIZE IN D/L										
13	NO SHELL/SERV ONE 30 FT/SHELL 240 TOTAL SOFT 240 /SERV										
14	NO SHELL/SERV. TOTAL m ² /SERV		240 SOFT	35	8400						
15	SHELL SIDE C.A. 1/8" mm										
16	MAT CS										
17	DES PRESS 150 PSIG 175 PSIG										
18	DES TEMP 300 OF 650 OF										
19	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT										
20	TUBE ENDS WELDED NO. TUBES INSUL ERECT WT										
21	EA. 203 378 TOWER OVERHEAD CONDENSER ✓										
22	SIZE IN D/L										
23	NO SHELL/SERV ONE 30 FT/SHELL 5250 TOTAL SOFT 5250 /SERV										
24	NO SHELL/SERV. TOTAL m ² /SERV		5250 SOFT	10	53000						
25	SHELL SIDE C.A. 1/8" mm										
26	MAT CS										
27	DES PRESS 75 PSIG 150 PSIG										
28	DES TEMP 400 OF 300 OF										
29	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT										
30	TUBE ENDS WELDED NO. TUBES INSUL ERECT WT										
TOTAL THIS PAGE											
TOTAL ACCOUNT											
CLIENT AMOCO, CODE - 4 REAT PLAINS GASE REACT		PROD FACT		LOC MM		BY 55 HHS		JOB NO. 5571		ACCT EA	
LOCATION ADELPHI, NORTH DAKOTA						DATE FEB. 1983		EST			



THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

AREA 200

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	TOTAL			UNIT	TOTAL	
1	EA-204 NAP. STABILISER FEED/BOTTOMS EXCHANGER V							
2	SIZE IN DIL mm DIL TYPE AES or DP	1						
3	NO SHELL/SERV. ONE SOFT/SHELL 100 TOTAL SOFT 100 /SERV		100 SOFT		5000			
4	NO SHELL/SERV. m ² /SHELL TOTAL m ² /SERV							
5	SHELL SIDE CA 1/8" mm TUBE SIDE CA 1/8" mm							
6	MAT CS							
7	DES PRESS 175 PSIG ¹⁰⁰ mm ² 150 PSIG ¹⁰⁰ mm ²							
8	DES TEMP 300 OF OC 400 OF OC							
9	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT ERECT WT							
10	TUBE ENDS WELDED NO TUBES INSUL ERECT WT							
11	EA-205 NAP. STABILISER REBOILER V	1						
12	SIZE IN DIL mm DIL TYPE AKT							
13	NO SHELL/SERV ONE SOFT/SHELL 370 TOTAL SOFT 370 /SERV		370 SOFT	25	9000			
14	NO SHELL/SERV m ² /SHELL TOTAL m ² /SERV							
15	SHELL SIDE CA 1/8" mm TUBE SIDE CA 1/8" mm							
16	MAT CS							
17	DES PRESS 150 PSIG ¹⁰⁰ mm ² 175 PSIG ¹⁰⁰ mm ²							
18	DES TEMP 400 OF OC 500 OF OC							
19	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT ERECT WT							
20	TUBE ENDS WELDED NO TUBES INSUL ERECT WT							
21	EA-206 NAP. STABILISER O/H CONDENSER V	1						
22	SIZE IN DIL mm DIL TYPE AEU or DP							
23	NO SHELL/SERV ONE SOFT/SHELL 170 TOTAL SOFT 170 /SERV		170 SOFT	40	6000			
24	NO SHELL/SERV m ² /SHELL TOTAL m ² /SERV							
25	SHELL SIDE CA 1/8" mm TUBE SIDE CA 1/8" mm							
26	MAT CS							
27	DES PRESS 150 PSIG ¹⁰⁰ mm ² 150 PSIG ¹⁰⁰ mm ²							
28	DES TEMP 300 OF OC 300 OF OC							
29	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT ERECT WT							
30	TUBE ENDS WELDED NO TUBES INSUL ERECT WT							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT: Vico /ORE - LOCAL PLANT'S GATE PANT		PROD FACT		LOC MM		JOB NO. 5571		ACCT
LOCATION: BELLAR ALP 174 24400A		WALF DATE		DATE FEB 1970		EST		EA

AREA 200

LUMMUS		ESTIMATE SHEET		THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM	SUBCONTRACT COST
		REQ	TOTAL			UNIT	TOTAL
1	EA. 207 STABILISED NAPHTHA COOLER ✓						
2	SIZE IN DIL						
3	NO SHELL/SERV. 300 SO FT/SHELL 300 TOTAL SOFT 300 /SERV		300 SOFT	30-	9 0000		
4	NO SHELL/SERV.						
5	SHELL SIDE C.A. 1/8" mm						
6	MAAT						
7	DES PRESS 150 PSIG/						
8	DES TEMP 300 OF						
9	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT						
10	TUBE ENDS WELDED NO TUBES INSUL ERECT WT						
11	EA. 208 MAKE-UP COMPRESSOR CIRCULATION COOLER ✓	1					
12	SIZE IN DIL						
13	NO SHELL/SERV ONE SO FT/SHELL 300 TOTAL SOFT 300 /SERV		300 SOFT	45-	13 500		
14	NO SHELL/SERV						
15	SHELL SIDE C.A. 1/8" mm						
16	MAAT						
17	DES PRESS 150 PSIG/						
18	DES TEMP 150 OF						
19	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT						
20	TUBE ENDS WELDED NO TUBES INSUL ERECT WT						
21	EA. 209 BA TAIL GAS COMPRESSOR AFTERCOOLER ✓	1					
22	SIZE IN DIL						
23	NO SHELL/SERV ONE SO FT/SHELL 1210 TOTAL SOFT 1210 /SERV		1210 SOFT	30-	36 300		
24	NO SHELL/SERV						
25	SHELL SIDE C.A. 1/8" mm						
26	MAAT						
27	DES PRESS 150 PSIG/						
28	DES TEMP 10 OF						
29	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT						
30	TUBE ENDS WELDED NO TUBES INSUL ERECT WT						
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT AMOCO /ODE - 4 DEPT PLAINS GASIF PLANT		PROD FACT		LOC MM		ACCT	
LOCATION ARLVLAFT NORTH ALBERTA		WAGE RATE		BY 65 1111		JOB NO. 5571	
				DATE 11.1.10		EST	
						EA	

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

F-33

AREA 200

THE LUMMUS COMPANY Bloomfield														
ESTIMATE SHEET														
DESCRIPTION														
QUANTITY														
MATERIAL COST														
UNIT COST														
STD LABOR MH														
SUBCONTRACT COST														
ACCT														
1	EC	201	HDS REACTOR EFFLUENT CONDENSER	FINNED	SOFT EA									
2	TOTAL BARE SURF	1700												
3	TOTAL BARE SURF													
4	TUBE MAT CS WITH DIA		IN	LENGTH	NO BUNDLES									
5	10 BWG TUBES		mm	LENGTH	NO ROWS	6								
6	DES PRESS	2600	PSIG	DES TEMP	475 °F	TOTAL HP	25							
7	DES PRESS		APR	DES TEMP	°C	TOTAL kW								
8	NO FANS ONE EA/HP	25	kW											
9	KNOCK DOWN/PREASSEMBLED													
10	INSUL					ERECT WT								
11	EC	202	JPB PRODUCT COOLER	FINNED	SOFT EA									
12	TOTAL BARE SURF	800												
13	TOTAL BARE SURF													
14	TUBE MAT CS DIA		IN	LENGTH	NO BUNDLES									
15			mm	LENGTH	NO ROWS	6								
16	DES PRESS	175	PSIG	DES TEMP	°F	TOTAL HP	10							
17	DES PRESS	450	APR	DES TEMP	°C	TOTAL kW								
18	NO FANS ONE EA/HP	10	kW											
19	KNOCK DOWN/PREASSEMBLED													
20	INSUL					ERECT WT								
21	EC													
22	TOTAL BARE SURF		FINNED		SOFT EA									
23	TOTAL BARE SURF		FINNED											
24	TUBE MAT DIA		IN	LENGTH	NO BUNDLES									
25			mm	LENGTH	NO ROWS									
26	DES PRESS		PSIG	DES TEMP	°F	TOTAL HP								
27	DES PRESS		APR	DES TEMP	°C	TOTAL kW								
28	NO FANS EA/HP		kW											
29	KNOCK DOWN/PREASSEMBLED													
30	INSUL					ERECT WT								
TOTAL THIS PAGE														
TOTAL ACCOUNT														
CLIENT <i>Amoco/POE - GREAT PLAINS GASIF. PLANT</i>														
LOCATION <i>BEULAH, NORTH DAKOTA</i>														
PROJECT <i>JET FUEL FROM CCAL DRUMS LIQUIDS</i>														
BY <i>HHK</i> JOB NO. <i>5571</i>														
DATE <i>FEB. 1981</i>														
HFV <i>0</i>														
ACCT <i>EC</i>														

AREA 200



ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

ITEM	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	FA-201 HDS FEED SURGE DRUM ✓							
2	5'-0" ID 25'-0" TT TK 30' SKIRT HT	1						
3	mm <input type="checkbox"/>							
4	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" /		13000 LBS	172	23 000			
5	DES PRESS 75 PSIG DES TEMP 500 OF							
6	DES PRESS 75 PSIG DES TEMP 500 OF							
7	X-RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
8	INTERNAL VORTEX BREAKER							
9								
10	INSUL <input checked="" type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/> ERECT WT							
11	FA-202 HDS REACTOR EFFLUENT HP/LT SEPARATOR ✓	1						
12	5'-0" ID 15'-0" TT TK MIN. SKIRT HT		71000 LBS	21	140 000			
13	mm <input type="checkbox"/>							
14	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" /							
15	DES PRESS 2600 PSIG DES TEMP 500 OF							
16	DES PRESS 2600 PSIG DES TEMP 500 OF							
17	X-RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
18	INTERNAL Baffles ; VORTEX BREAKERS							
19								
20	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/> ERECT WT							
21	FA-203 HDS RECYCLE GAS COMP. SUCT. K.O. DRUM ✓	1						
22	2'-0" ID 5'-0" TT TK MIN. SKIRT HT		6500 LBS	4	26 000			
23	mm <input type="checkbox"/>							
24	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" /							
25	DES PRESS 2600 PSIG DES TEMP 500 OF							
26	DES PRESS 2600 PSIG DES TEMP 500 OF							
27	X-RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
28	INTERNAL NONE							
29								
30	INSUL <input checked="" type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/> ERECT WT							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT: AMOCO / DOE - GREAT PLAINS GASIF. PLANT		PROD FACT	LOC M H	BY	DATE	REV	JOB NO.	ACCT
LOCATION: BEULAH NORTH DAKOTA		WAGE RATE	LAB COST	EST	FA		5571	FA
PROJECT: TET FUEC / KNOX COAL DERIVED LIQUIDS								

ESTIMATE SHEET

THE LUNNUS COMPANY
Bloomfield

ITEM NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	FA-204 JPB TOWER FEED SURGE DRUM V	1						
2	5'-0" ID 20'-0" TT TK MIN. SKIRT HT							
3	m <input type="checkbox"/> mm <input type="checkbox"/>							
4	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" /							
5	DES PRESS 500 PSIG DES TEMP 300 OF							
6	DES PRESS ^{HPA} _{PSIG} DES TEMP °C							
7	X-RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
8	INTERNAL IMPINGEMENT RAFFLE; VORTEX BREAKER							
9								
10	INSUL <input checked="" type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/> ERECT WT							
11	FA-205 JPB TOWER OVERHEAD REFLUX/PROD. DRUM V	1						
12	5'-0" ID 20'-0" TT TK 30' SKIRT HT							
13	m <input type="checkbox"/> mm <input type="checkbox"/> WITH 2' ϕ x 5' T/T WATER BOOT							
14	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" /							
15	DES PRESS 75 PSIG DES TEMP 300 OF							
16	DES PRESS ^{HPA} _{PSIG} DES TEMP °C							
17	X-RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
18	INTERNAL: VORTEX BREAKER							
19								
20	INSUL <input type="checkbox"/> HORIZ <input checked="" type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/> ERECT WT							
21	FA-206 NAR. STABILISER OVERHEAD REFLUX DRUM ✓	1						
22	2'-0" ID 5'-0" TT TK 15' SKIRT HT							
23	m <input type="checkbox"/> mm <input type="checkbox"/>							
24	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" /							
25	DES PRESS 150 PSIG DES TEMP 300 OF							
26	DES PRESS ^{HPA} _{PSIG} DES TEMP °C							
27	X-RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
28	INTERNAL VORTEX BREAKER							
29								
30	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/> ERECT WT							
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							
	CLIENT AMUNCO / DOE - GREAT PLAINS GASIF. PLANT							
	LOCATION BEULAH NORTH DAKOTA							
	PROJECT TET FUEL FROM COAL DERIVED LIQUIDS							
	PROD FACT							
	WAGE RATE							
	BY							
	DATE							
	REV							
	JOB NO.							
	EST							
	ACCT							
	FA							

101.8 AFV. 2

AREA 200

THE LUMMUS COMPANY Bloomfield		ESTIMATE SHEET									
DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST				
	REQ	EA			UNIT	TOTAL					
1 FA											
2											
3 1" ID	TT	TK	SKIRT MT								
4 MAT											
5 DES PRESS	CLAD	LINING	CA								
6 DES PRESS			PSIG	DES TEMP							
7 X RAY SPOT	100%	STRESS REL	FAB SHOP	FIELD							
8 INTERNALS											
9											
10 INSUL	HORIZ	VERT	SPHERE								
11 FA											
12											
13 1" ID	TT	TK	SKIRT MT								
14 MAT											
15 DES PRESS	CLAD	LINING	CA								
16 DES PRESS			PSIG	DES TEMP							
17 X RAY SPOT	100%	STRESS REL	FAB SHOP	FIELD							
18 INTERNALS											
19											
20 INSUL	HORIZ	VERT	SPHERE								
21 FA 207 PSA UNIT FEED GAS K.O. DRUM											
22 3'-6" ID	TT	TK	MIN. SKIRT MT								
23 1" ID											
24 MAT	CS	CLAD	LINING	CA	1/8"						
25 DES PRESS			375	PSIG	DES TEMP	300					
26 DES PRESS				PSIG	DES TEMP						
27 X RAY SPOT	100%	STRESS REL	FAB SHOP	FIELD							
28 INTERNALS											
29											
30 INSUL	HORIZ	VERT	SPHERE								
TOTAL THIS PAGE											
TOTAL ACCOUNT											
CLIENT	AMOCO / DUE - GREAT PLAINS GASIF. PLANT										
LOCATION	BEULAH NORTH DAKOTA										
PROJECT	JET FUEC FROM COAL DERIVED LIQUIDS										

BY	THK	JOB NO.	5571	ACCT
DATE	11/8/71	EST		FA
REV	0			

A172 1081-B REV 2

AREA 200

LUMMUS		ESTIMATE SHEET				THE LUMMUS COMPANY Bloomfield			
DESCRIPTION	QUANTITY	UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST	REF	EA	TONS	LBS
1 FA 20B MAKE-UP #2 COMPRESSOR SECTION K.O. DRUM									
2 2'-0" ID 5'-0" TT TK SKIRT HT	1		4500						
3 m <input type="checkbox"/> mm <input type="checkbox"/>									
4 MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" /									
5 DES PRESS 375 PSIG DES TEMP 300 OF									
6 DES PRESS 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>									
7 X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>									
8 INTERNALS MIST ILLUMINATOR (411 SS)									
9									
10 INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>									
11 FA 20B PSA TAIL GAS K.O. DRUM									
12 2'-0" ID 5'-0" TT TK SKIRT HT	1		4500						
13 m <input type="checkbox"/> mm <input type="checkbox"/>									
14 MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" /									
15 DES PRESS 410 PSIG DES TEMP 300 OF									
16 DES PRESS 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>									
17 X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>									
18 INTERNALS									
19									
20 INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>									
21 FA									
22 ID TT TK SKIRT HT									
23 m <input type="checkbox"/> mm <input type="checkbox"/>									
24 MAT CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA /									
25 DES PRESS 375 PSIG DES TEMP 300 OF									
26 DES PRESS 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>									
27 X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>									
28 INTERNALS									
29									
30 INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>									
TOTAL THIS PAGE									
TOTAL ACCOUNT									
CLIENT 4400/DOE GREAT BASINS GRIFFIN PLANT	PROD FACT	LOC M.H.	LAB COST	BY GS	JOB NO. 5571	ACCT			
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE			DATE 4-19-89	EST	FA			
PROJECT 357 DEL FROM OAL DERIVED LIQUIDS				REV 1					

Area 200

LUNARUS Bloomfield		ESTIMATE WORKSHEET										JOB NO. 5571		ACCT. GA
DESCRIPTION		QUANTITY	UNIT	STO. LABOR MH	LOCATION	UNIT	MATERIAL	SUB CONTRACT	TOTAL COST	BY	DATE	REV		
		AMOUNT	MEAS	UNIT	LABOR COST	(1) x (2) x (3)	COST	COST	M + L + S + T	HHK	FEB. 1959	2		
1	GA - 201 A/S HDS FEED PUMP AND SPARE ✓	TWO	No				200 000							
2	GPM 135 SUCT 50 PSIG DISCH 2550 PSIG													
3	TEMP 1403 OF 50Gr. 73 ΔP 7911 FT 2500 PSI													
4	MAT'L CASE CI IMPELLER 13 C2													
5	TYPE CENTRIF. MFR 290 MP RPM													
6	DRIVER MOTOR													
7	PULSATION DAMPENERS AT SUCTION AND													
8	DISCHARGE													
9	INSUL YES/NO ERECT WT. PUMP & DRIVER													
10	GA - 202 A/S JPB TOWER O/H REFLEX/PROD. PUMP AS ✓	TWO	No				20 000							
11	GPM 260 SUCT 15 PSIG DISCH 155 PSIG													
12	TEMP 120 OF 50Gr. 71 ΔP 456 FT 140 PSI													
13	MAT'L CASE CI IMPELLER CS													
14	TYPE CENTRIF. MFR													
15	DRIVER MOTOR 31 HP RPM													
16														
17														
18	INSUL YES/NO ERECT WT. PUMP & DRIVER													
19	GA - 203 A/S JPB PRODUCT PUMP & SPARE ✓	TWO	No				15 000							
20	GPM 125 SUCT 16 PSIG DISCH 96 PSIG													
21	TEMP 1435 OF 50Gr. 84 ΔP 220 FT 80 PSI													
22	MAT'L CASE CI IMPELLER CS													
23	TYPE CENTRIF. MFR													
24	DRIVER MOTOR 10 HP RPM													
25														
26														
27	INSUL YES/NO ERECT WT. PUMP & DRIVER													
28														
29	TOTAL THIS PAGE													
30	TOTAL ACCOUNT GA													
31	CLIENT DOE/AMMO - GREAT PLAINS GASIF PLANT													
32	LOCATION BEULAH - NORTH DAKOTA													
33	PROJECT JET FUEL FROM COAL DERIVED LIQUIDS													

Area 200

ESTIMATE WORKSHEET		QUANTITY		STD LABOR MH		LOCATION		UNIT COST		MATERIAL		SUB CONTRACT		TOTAL COST	
DESCRIPTION		AMOUNT	UNIT	UNIT	TOTAL	LAUREL COST	(1) - (2) - (3)			COST		COST		M + L + S	
1	GA - 204 A/S 178 TOWER BOTTLS PUMP & SPARE ✓	TWO								15000					
2	GPM 65 SUCT 20 PSIG DISCH 105 PSIG														
3	TEMP 590 OF SpGr. 91 ΔP 216 FT 85 PSI														
4	MAT'L CASE CS IMPELLER 13 CS														
5	TYPE CENTRIF. IMFR														
6	DRIVER MOTOR 6 HP RPM														
7															
8															
9	INSUL YES/NO ERECT WT. PUMP & DRIVER														
10	GA - 205 A/S NAF STABILISER REFLUX PUMPS ✓	TWO								15000					
11	GPM 10 SUCT 110 PSIG DISCH 170 PSIG														
12	TEMP 180 OF SpGr. 5 ΔP 277 FT 60 PSI														
13	MAT'L CASE CS IMPELLER CS														
14	TYPE CENTRIF. IMFR														
15	DRIVER MOTOR 3/4 HP RPM														
16															
17															
18	INSUL YES/NO ERECT WT. PUMP & DRIVER														
19	GA - 206 A/S HP WASH WATER PUMP & SPARE ✓	TWO								50000					
20	GPM 10 SUCT 350 PSIG DISCH 2450 PSIG														
21	TEMP 100 OF SpGr. 1.0 ΔP 4851 FT 2100 PSI														
22	MAT'L CASE CS IMPELLER CS														
23	TYPE RECIP. IMFR														
24	DRIVER MOTOR 25 HP RPM														
25															
26															
27	INSUL YES/NO ERECT WT. PUMP & DRIVER														
28															
29	TOTAL THIS PAGE														
30	TOTAL ACCOUNT GA														
31	CLIENT DOE/ANSCO - GREAT PLAINS BASIN PLANT														
32	LOCATION RED LAKH NORTH DAKOTA														
33	PROJECT 111 FULL FLOW COAL W/ PUMP & TRUCK														

AREA

ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield						
DESCRIPTION										QUANTITY	UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST		
										REQ	EA		UNIT	TOTAL		
1	GB-201 A/S HDS RECYCLE GAS COMPRESSOR										2					
2	CAP SCFM 3020 STM PSIG/ NP ₂ 1.085															
3	MAT'L HANDLED H ₂ RICH GAS												300000			
4	SUCTION 2350 PSIA/ NP ₂ 3.56 MW															
5	DISCH 2550 PSIA/ NP ₂ 120 °F															
6	MAT CASE 2 MOL% H ₂ S 90% H ₂ IMPELLER															
7	DRIVER EM TURB DIESEL 88 BHP /															
8	INCL GEAR LUBE & SEAL INTERCOOLER COND															
9	TYPE CENT RECIP ROTARY SCREW															
10	INSUL ERECT WT COMPR + DRIVE															
11	GB-202 A/S MAKE-UP H ₂ COMPRESSOR PACKAGE										2					
12	CAP SCFM 10760 STM PSIG/ NP ₂ 1.975 MW												2,000 000			
13	MAT'L HANDLED															
14	SUCTION 340 PSIA/ NP ₂ 6.5 °F															
15	DISCH 2520 PSIA/ NP ₂ 1.4															
16	MAT CASE CS IMPELLER CS															
17	DRIVER EM TURB DIESEL 2870 BHP /															
18	INCL GEAR LUBE & SEAL INTERCOOLER COND															
19	TYPE CENT RECIP ROTARY SCREW															
20	INSUL ERECT WT COMPR + DRIVE															
21	GB-203 A/S PSA TAIL GAS COMPRESSOR PACKAGE										2					
22	CAP SCFM 9080 STM PSIG/ NP ₂ 2.66 MW												2,800 000			
23	MAT'L HANDLED															
24	SUCTION 20 PSIA/ NP ₂ 110 °F															
25	DISCH 375 PSIA/ NP ₂ 1.25															
26	MAT CASE CS IMPELLER CS															
27	DRIVER EM TURB DIESEL 4000 BHP /															
28	INCL GEAR LUBE & SEAL INTERCOOLER COND															
29	TYPE CENT RECIP ROTARY SCREW															
30	INSUL ERECT WT COMPR + DRIVE															
TOTAL THIS PAGE																
TOTAL ACCOUNT																
CLIENT DOE/AMOCO GREAT PLAINS GASIFICATION PLANT										LOC MH		BY GS	JOB NO 5571	ACCT		
LOCATION BEULAH, NORTH DAKOTA										IAR COST		DATE 4-19-89	EST	GB		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS												REV 1				



LUMMUS

FLUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY

Bloomfield

LINE NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	PA-201 PSA PACKAGE UNIT TO PURIFY THE MAKE-UP H ₂	1						
2	Feed gas conditions							
3	H ₂ 63.19 mol%							712
4	CO 18.61 "				5,000.00			7,500.00
5	CO ₂ 1.48 "							
6	CH ₄ 16.31 "							
7	C ₂ H ₆ .31 "							
8	N ₂ /Argon .19 "							
9	H ₂ O .01 "							
10	100.00							
11	CO ₂ , H ₂ S, C ₂ H ₆ 100 ppmv (max)							
12	Temp @ B.L. 65 °F							
13	Pressure @ B.L. 350 psig							
14	Capacity - Normal 28.1 MMSCFD							
15	Design 33 "							
16	Product Hydrogen							
17	Hydrogen purity : 99.9 plus mol%							
18	Hydrogen recovery : 75% (min)							
19	Scope of supply							
20	From outlet of feed gas flow control valve							
21	To product hydrogen and tail gas without any							
22	compression							
23	Utility available							
24	Electric power; nitrogen							
25	!							
26	!							
27	!							
28	!							
29	!							
30	!							
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							
	CLIENT DOE/AMOCO - GREAT PLAINS GASIF PLANT	PROD FACT	LOC. MH	ACCT	BY	HHK	JOB NO	5571
	LOCATION BEULAH, NORTH DAKOTA	WAGE RATE			DATE	FEB. 1989	EST	PA
	PROJECT NO. 1001-10-00 DIVISION 6000-10-00				REV	0		

AREA 300

LCI PROJECT 5571
TASK 4.0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571

DATE/BY: 21-Apr-89
 03:05 PM

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>	1	\$60	100%	\$60
<u>TOWERS</u>			110%	
<u>INTERNALS</u>				
<u>REACTORS</u>	1	\$560	70%	\$392
<u>EXCHANGERS</u>	2	\$85	100%	\$85
<u>AIR COOLERS</u>	1	\$70	100%	\$70
<u>VESSELS</u>	3	\$85	120%	\$102
<u>TANKS</u>				
<u>FILTERS</u>				
<u>PUMPS</u>	2	\$100	100%	\$100
<u>COMPRESSORS</u>	2	\$400	80%	\$320
<u>PACKAGE UNITS</u>				
<u>TOTAL</u>	12	\$1,360		\$1,129

SUMMARY

<u>EQUIPMENT</u>	\$1,360
<u>COMMODITIES</u>	\$1,129
<u>LABOR</u>	\$813 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$813 (100% LABOR)
<u>ENGINEERING</u>	<u>\$720</u> (1000/PC X \$60)
<u>SUBTOTAL</u>	\$4,836
<u>CONTINGENCY</u>	<u>\$967</u> (20%)
<u>TOTAL</u>	\$5,803

AREA 300

THE LUMMUS COMPANY Shawfield									
ESTIMATE SHEET									
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST		ACCT
REQ	EA					UNIT	TOTAL		
1	BA-301 HGR FEED HEATER								
2	ASSEMBLED DUTY								
3	MM Bush								
4	LW								
5	DES PRESS								
6	DES TEMP								
7	MAT TUBES								
8	TYPE								
9	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
10	BA								
11	ASSEMBLED DUTY								
12	MM Bush								
13	LW								
14	DES PRESS								
15	DES TEMP								
16	MAT TUBES								
17	TYPE								
18	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
19	BA								
20	ASSEMBLED DUTY								
21	MM Bush								
22	LW								
23	DES PRESS								
24	DES TEMP								
25	MAT TUBES								
26	TYPE								
27	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
28	BA								
29	ASSEMBLED DUTY								
30	MM Bush								
31	LW								
32	DES PRESS								
33	DES TEMP								
34	MAT TUBES								
35	TYPE								
36	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
37	BA								
38	ASSEMBLED DUTY								
39	MM Bush								
40	LW								
41	DES PRESS								
42	DES TEMP								
43	MAT TUBES								
44	TYPE								
45	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
46	BA								
47	ASSEMBLED DUTY								
48	MM Bush								
49	LW								
50	DES PRESS								
51	DES TEMP								
52	MAT TUBES								
53	TYPE								
54	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
55	BA								
56	ASSEMBLED DUTY								
57	MM Bush								
58	LW								
59	DES PRESS								
60	DES TEMP								
61	MAT TUBES								
62	TYPE								
63	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
64	BA								
65	ASSEMBLED DUTY								
66	MM Bush								
67	LW								
68	DES PRESS								
69	DES TEMP								
70	MAT TUBES								
71	TYPE								
72	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
73	BA								
74	ASSEMBLED DUTY								
75	MM Bush								
76	LW								
77	DES PRESS								
78	DES TEMP								
79	MAT TUBES								
80	TYPE								
81	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
82	BA								
83	ASSEMBLED DUTY								
84	MM Bush								
85	LW								
86	DES PRESS								
87	DES TEMP								
88	MAT TUBES								
89	TYPE								
90	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
91	BA								
92	ASSEMBLED DUTY								
93	MM Bush								
94	LW								
95	DES PRESS								
96	DES TEMP								
97	MAT TUBES								
98	TYPE								
99	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
100	BA								
101	ASSEMBLED DUTY								
102	MM Bush								
103	LW								
104	DES PRESS								
105	DES TEMP								
106	MAT TUBES								
107	TYPE								
108	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
109	BA								
110	ASSEMBLED DUTY								
111	MM Bush								
112	LW								
113	DES PRESS								
114	DES TEMP								
115	MAT TUBES								
116	TYPE								
117	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
118	BA								
119	ASSEMBLED DUTY								
120	MM Bush								
121	LW								
122	DES PRESS								
123	DES TEMP								
124	MAT TUBES								
125	TYPE								
126	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
127	BA								
128	ASSEMBLED DUTY								
129	MM Bush								
130	LW								
131	DES PRESS								
132	DES TEMP								
133	MAT TUBES								
134	TYPE								
135	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
136	BA								
137	ASSEMBLED DUTY								
138	MM Bush								
139	LW								
140	DES PRESS								
141	DES TEMP								
142	MAT TUBES								
143	TYPE								
144	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
145	BA								
146	ASSEMBLED DUTY								
147	MM Bush								
148	LW								
149	DES PRESS								
150	DES TEMP								
151	MAT TUBES								
152	TYPE								
153	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
154	BA								
155	ASSEMBLED DUTY								
156	MM Bush								
157	LW								
158	DES PRESS								
159	DES TEMP								
160	MAT TUBES								
161	TYPE								
162	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
163	BA								
164	ASSEMBLED DUTY								
165	MM Bush								
166	LW								
167	DES PRESS								
168	DES TEMP								
169	MAT TUBES								
170	TYPE								
171	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
172	BA								
173	ASSEMBLED DUTY								
174	MM Bush								
175	LW								
176	DES PRESS								
177	DES TEMP								
178	MAT TUBES								
179	TYPE								
180	PREHEATER <input type="checkbox"/> ECONOMIZER <input type="checkbox"/>								
181	BA								
182	ASSEMBLED DUTY								
183	MM Bush								
184	LW								
185	DES PRESS								
186	DES TEMP								

THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

AREA 300

NO	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	DC 301 HCR REACTOR ✓							
2	6'-0" ID 30'-0" TT TK MIN SKIRTM	1	140,000	4-	560,000			
3	m <input type="checkbox"/> mm <input type="checkbox"/>							
4	MAT 2 1/4 Cr - 1/2 Mo CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" mm							
5	DES PRESS 1900 PSIG DES TEMP 750 °F							
6	DES PRESS kg/cm² DES TEMP °C							
7	X RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
8	INTERNAL CATALYST BED SUPPORT, HOLDOWN PLATES, GAS							
9	DISTRIBUTORS, 5 CATALYST BEDS (3'-6", 7'-6" EACH)							
10	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> ERECT WT			TONS				
11	DC							
12	ID TT TK SKIRTM							
13	m <input type="checkbox"/> mm <input type="checkbox"/>							
14	MAT CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA mm							
15	DES PRESS PSIG DES TEMP °F							
16	DES PRESS kg/cm² DES TEMP °C							
17	X RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
18	INTERNAL							
19	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> ERECT WT			TONS				
20	DC							
21	ID TT TK SKIRTM							
22	m <input type="checkbox"/> mm <input type="checkbox"/>							
23	MAT CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA mm							
24	DES PRESS PSIG DES TEMP °F							
25	DES PRESS kg/cm² DES TEMP °C							
26	X RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
27	INTERNAL							
28	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> ERECT WT			TONS				
29	TOTAL THIS PAGE							
30	TOTAL ACCOUNT							
CLIENT Doe/Amoco - GREAT PLAINS GASIF PLANT		PROD FACT		LOC MH		JOB NO 5571		ACCT
LOCATION BEULAH, NORTH DAKOTA		WASTE RATE		LAB COST		DATE FEB 1983		DC
PROJECT JET FUEL FROM COAL DERIVED FUELING						REV 0		

AREA 300



THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

ITEM	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	TOTAL			UNIT	TOTAL	
1	EA 301 HCR REACTOR FEED/EFFLUENT EXCHANGER / TYPE DES OR EQUIV.	1						
2	SIZE IN D/L							
3	NO SHELL/SERV. ONE SO FT/SHELL 800 TOTAL SO FT 800 /SERV		800 SO FT	100	80,000			
4	NO SHELL/SERV. m ² /SHELL TOTAL m ² /SERV							
5	SHELL SIDE C.A. 1/8" / mm TUBE SIDE C.A. 1/8" / mm							
6	MAT CS - 1/2 Mo 2 1/4 C ₂ - 1/2 Mo							
7	DES PRESS 2250 PSIG / m ² 1900 PSIG / m ²							
8	DES TEMP 650 °F / °C 750 °F / °C							
9	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT							
10	TUBE ENDS WELDED NO TUBES INSUL ERECT WT							
11	EA 302 HCR RECYCLE COMPRESSOR CIRC. COOLER / TYPE DOUBLE PIPE	1						
12	SIZE IN D/L							
13	NO SHELL/SERV. ONE SO FT/SHELL 180 TOTAL SO FT /SERV		180 SO FT	5000				
14	NO SHELL/SERV. m ² /SHELL TOTAL m ² /SERV							
15	SHELL SIDE C.A. 7/8" / mm TUBE SIDE C.A. / mm							
16	MAT CS							
17	DES PRESS 150 PSIG / m ² 1900 PSIG / m ²							
18	DES TEMP 150 °F / °C 200 °F / °C							
19	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT							
20	TUBE ENDS WELDED NO TUBES INSUL ERECT WT							
21	EA							
22	SIZE IN D/L							
23	NO SHELL/SERV. SO FT/SHELL TOTAL SO FT /SERV							
24	NO SHELL/SERV. m ² /SHELL TOTAL m ² /SERV							
25	SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm							
26	MAT							
27	DES PRESS PSIG / m ² PSIG / m ²							
28	DES TEMP °F / °C °F / °C							
29	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT							
30	TUBE ENDS WELDED NO TUBES INSUL ERECT WT							
TOTAL THIS PAGE								
TOTAL ACCOUNT								

CLIENT APIO Co. / DOE - 4 REAL PLAINS GASIF. PLANT
LOCATION BELL LAH, NORTH DAKOTA

BY 55 HRS JOB NO 5571
DATE FEB 1981 EST
REV

LOC MM TONS EA
LAB COST

ACCT EA

THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

AREA 300

NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	TOTAL			UNIT	TOTAL	
1	EC 301 HCR REACTOR EFFLUENT CONDENSER ✓	1						
2	TOTAL BARE SURF 2000 FINNED/ SOFTEA							
3	TOTAL BARE SURF FINNED/ m ² EA			35	70 000			
4	TUBE MAT CS DIA IN LENGTH NO BUNDLES							
5	DES PRESS 1900 PSIG DES TEMP 450 °F TOTAL HP							
6	DES PRESS 1900 PSIG DES TEMP °C TOTAL kW							
7	DES PRESS 1900 PSIG DES TEMP °C TOTAL kW							
8	NO FANS 1 EA/HP 2.5 kW							
9	KNOCK DOWN/PREASSEMBLED							
10	INSUL <input type="checkbox"/>							
11	EC							
12	TOTAL BARE SURF FINNED/ SOFTEA							
13	TOTAL BARE SURF FINNED/ m ² EA							
14	TUBE MAT DIA IN LENGTH NO BUNDLES							
15	DES PRESS PSIG DES TEMP °F TOTAL HP							
16	DES PRESS 1900 PSIG DES TEMP °C TOTAL kW							
17	DES PRESS 1900 PSIG DES TEMP °C TOTAL kW							
18	NO FANS 1 EA/HP 2.5 kW							
19	KNOCK DOWN/PREASSEMBLED							
20	INSUL <input type="checkbox"/>							
21	EC							
22	TOTAL BARE SURF FINNED/ SOFTEA							
23	TOTAL BARE SURF FINNED/ m ² EA							
24	TUBE MAT DIA IN LENGTH NO BUNDLES							
25	DES PRESS PSIG DES TEMP °F TOTAL HP							
26	DES PRESS 1900 PSIG DES TEMP °C TOTAL kW							
27	DES PRESS 1900 PSIG DES TEMP °C TOTAL kW							
28	NO FANS 1 EA/HP 2.5 kW							
29	KNOCK DOWN/PREASSEMBLED							
30	INSUL <input type="checkbox"/>							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT <i>Applco/POE-GREAT PLAINS GASIF. PLANT</i>		PROD FACT		LOC M.H.		BY <i>HLK</i>		ACCT
LOCATION <i>BEULAH, NORTH DAKOTA</i>		WAGE RATE		LAB COST		DATE FEB 1989		EST
PROJECT <i>JET FUEL FROM COAL IN 2000 LIGUIDS</i>						REV 0		EC

AREA 300

THE LUMMUS COMPANY Bismarck, ND		ESTIMATE SHEET									
ITEM NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST	ACCT		
		REQ	EA			UNIT	TOTAL				
1	FA-301 HCR FEED SURGE DRUM 4'-0" ID 16'-0" TT TK 20' SKIRT HT	1	6000 LBS	25%	15,600						
2	INSUL										
3	MAT CS CLAD Lining CA 1/8"										
4	DES PRESS 75 PSIG DES TEMP 400 OF										
5	DES PRESS 100% STRESS REL FAB-SHOP FIELD										
6	INTERNAL: VORTEX BREAKER										
7	INSUL										
8	FA-302 HCR REACTOR EFFLUENT H/LT SEPARATOR 4'-0" ID 12'-0" TT TK MIN SKIRT HT	1	30000 LBS	25%	60,000						
9	INSUL										
10	MAT CS CLAD Lining CA 1/8"										
11	DES PRESS 1900 PSIG DES TEMP 300 OF										
12	DES PRESS 100% STRESS REL FAB-SHOP FIELD										
13	INTERNAL: DIVIDING BAFFLE; VORTEX BREAKER										
14	INSUL										
15	FA-303 HCR RECYCLE COMPRESSOR K.O. DRUM 2'-6" ID 8'-0" TT TK SKIRT HT	1	4000 LBS	25%	10,000						
16	INSUL										
17	MAT CS CLAD Lining CA 1/8"										
18	DES PRESS 1900 PSIG DES TEMP 200 OF										
19	DES PRESS 100% STRESS REL FAB-SHOP FIELD										
20	INTERNAL: DIVIDING BAFFLE; VORTEX BREAKER										
21	INSUL										
22	FA-304 HCR RECYCLE COMPRESSOR K.O. DRUM 2'-6" ID 8'-0" TT TK SKIRT HT	1	4000 LBS	25%	10,000						
23	INSUL										
24	MAT CS CLAD Lining CA 1/8"										
25	DES PRESS 1900 PSIG DES TEMP 200 OF										
26	DES PRESS 100% STRESS REL FAB-SHOP FIELD										
27	INTERNAL: DIVIDING BAFFLE; VORTEX BREAKER										
28	INSUL										
29	FA-305 HCR RECYCLE COMPRESSOR K.O. DRUM 2'-6" ID 8'-0" TT TK SKIRT HT	1	4000 LBS	25%	10,000						
30	INSUL										
TOTAL THIS PAGE											
TOTAL ACCOUNT											
CLIENT: AMOCO / DOE - GREAT PLAINS GASIF. PLANT		PROD FACT		LOC. MH.		BY		ACCT			
LOCATION: BEULAH NORTH DAKOTA		WAGE RATE		LAB COST		DATE FEB 1981		JOB NO. 5571			
PROJECT: TET FUEL FROM COAL DERIVED LIQUIDS						REV 1		FA			

Area 300



ESTIMATE WORKSHEET

DESCRIPTION		QUANTITY	UNIT	PRODUC TIVITY FACTOR (2)	LOCATION MH	WAGE RATE (3) \$/MH	BY	DATE	REV	JOB NO.	EST	ACCT
AMOUNT	UNIT	PRODUC TIVITY FACTOR (2)	LOCATION MH	WAGE RATE (3) \$/MH	BY	DATE	REV	JOB NO.	EST	ACCT		
1	GA - 301 1/2 HCR FEED PUMP & SPARE	2	No									
2	GPM 60 SUCT 50 PSIG DISCH 1850 PSIG											
3	TEMP 300 of SpGr .93 ΔP 5010 FT 1800 PSI											
4	MAT'L CASE CI IMPELLER CS											
5	TYPE CENTRIF MFR STGS											
6	DRIVER MOTOR 105 HP RPM											
7												
8												
9	INSUL YES/NO ERECT WT. PUMP & DRIVER											
10	GA											
11	GPM SUCT PSIG DISCH											
12	TEMP of SpGr ΔP FT											
13	MAT'L CASE IMPELLER											
14	TYPE MFR STGS											
15	DRIVER HP RPM											
16												
17												
18	INSUL YES/NO ERECT WT. PUMP & DRIVER											
19	GA											
20	GPM SUCT PSIG DISCH											
21	TEMP of SpGr ΔP FT											
22	MAT'L CASE IMPELLER											
23	TYPE MFR STGS											
24	DRIVER HP RPM											
25												
26												
27	INSUL YES/NO ERECT WT. PUMP & DRIVER											
28												
29	TOTAL THIS PAGE											
30	TOTAL ACCOUNT GA											
31	CLIENT USE/AMOCO - GREAT PLAINS GASIF. PLANT											
32	LOCATION BEULAH, NORTH DAKOTA											
33	PROJECT JET FUEL FROM COAL DERIVED LIQUIDS											

Area 300



ESTIMATE WORKSHEET

LINE NO.	DESCRIPTION	QUANTITY		STD. LABOR MH	LOCATION LABOR COST (1) x (2) x (3)	UNIT COST	MATERIAL COST	SUB. CONTRACT COST	TOTAL COST M + L + S/C
		AMOUNT	UNIT MEAS.						
1	GB - 301 A/S HCR RECYCLE GAS COMPRESSOR / STAGE	2	No.						
2	CAP. ACTUAL SUCTION CFM 182.1						400.000		
3	MATERIAL HANDLED H ₂ -RICH GAS (90.8 MULE%) 14.10 MW								
4	SUCT. 1650 PSIA TEMP 120 OF P2/P1								
5	DISCH. 1850 PSIA C ₀ /C _v 1.38 STGS ONE								
6	MAT'L: CASE IMPELLER								
7	TYPE RECIP. MFR RPM								
8	INCL: Gear Lub & Seal Intercool Cond								
9									
10									
11	DRIVER MOTOR 344 HP RPM		No.						
12	VOLTAGE STEAM-PSIG IN OUT								
13									
14	INSUL YES/NO ERECT WT COMPR + DR -		tons ee						
15	GB		No.						
16	CAP. ACTUAL SUCTION CFM								
17	MATERIAL HANDLED MW								
18	SUCT. PSIA TEMP OF P2/P1								
19	DISCH. PSIA C ₀ /C _v STGS								
20	MAT'L: CASE IMPELLER								
21	TYPE MFR RPM								
22	INCL: Gear Lub & Seal Intercool Cond								
23									
24									
25	DRIVER HP RPM		No.						
26	VOLTAGE STEAM-PSIG IN OUT								
27									
28	INSUL YES/NO ERECT WT COMPR + DR -		tons ee						
29	TOTAL THIS PAGE								
30	TOTAL ACCOUNT GB								
31	CLIENT DOE/ANMCOB - GREAT PLAINS GASIF. PLANT	TYPE OF ESTIMATE		PRODUCTIVITY FACTOR (2)		BY HHK		JOB NO. 5571	
32	LOCATION BEULAH NORTH DAKOTA	LOCATION MH		DATE 11.8.1989		REV. 0		ACCT GB	
33	PROJECT TEST FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE (3) \$/MH							

A122 05/6 11

AREA 500

CLIENT:DOE

PROJECT:5571

LOCATION:BEULAH,ND.

PROJECT:JET FUEL

DATE/BY:

22-Mar-89

08:27 AM

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

HEATERS

TOWERS

INTERNALS

REACTORS

EXCHANGERS

AIR COOLERS

VESSELS

TANKS

FILTERS

PUMPS

COMPRESSORS

PACKAGE UNITS

4	\$105	120%	\$126
4	\$48	120%	\$58
8	\$153		\$184

TOTAL

SUMMARY

EQUIPMENT

\$153

COMMODITIES

\$184

LABOR

\$125 (10% EQUIP, 60% COMM)

INDIRECTS

\$125 (100% LABOR)

ENGINEERING

\$480 (1000/PC X \$60)

SUBTOTAL

\$1,068

CONTINGENCY

\$214 (20%)

TOTAL

\$1,281

ESCALATION

\$128

10%

TOTAL

\$1,409

CASE 1 MAXIMUM JP-4

500 AREA



LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

ITEM	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	FA 501 CATALYST OIL DRUM							
2	4'-6" ID 8'-0" TT TK SKIRT HT	1						
3	mm							
4	MAT CS CLAD Lining CA 1/8"							
5	DES PRESS 35 PSIG DES TEMP 650 OF							
6	DES PRESS 35 PSIG DES TEMP 650 OF							
7	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD							
8	INTERNAL:							
9								
10	INSUL HORIZ VERT SPHERE							
11	FA 502 CATALYST FEED HOPPER							
12	4'-0" ID 3'-0" TT TK SKIRT HT	1			5000			
13	mm							
14	MAT CS CLAD Lining CA 1/8"							
15	DES PRESS 35 PSIG DES TEMP 150 OF							
16	DES PRESS 35 PSIG DES TEMP 150 OF							
17	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD							
18	INTERNAL: CONE BOTTOM							
19								
20	INSUL HORIZ VERT SPHERE							
21	FA 503 CATALYST TRANSFER VESSEL							
22	3'-0" ID 8'-0" TT TK 5'-0" SKIRT HT	1			6000			
23	mm							
24	MAT 2 1/2" EC 1/4" CLAD Lining CA 1/4"							
25	DES PRESS 2600 PSIG DES TEMP 650 OF							
26	DES PRESS 2600 PSIG DES TEMP 650 OF							
27	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD							
28	INTERNAL:							
29								
30	INSUL HORIZ VERT SPHERE							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO / DOE - GREAT PLAINS GASIF. PLANT		PROD FACT	LOC. M.H.	LAB. COST	BY	DATE	REV.	ACCT
LOCATION BEULAH, NORTH DAKOTA					11/21/87	0		5571
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS								FA

CASE 1 MAXIMUM JP-4 500 AREA

THE LUMMUS COMPANY Bloomfield		ESTIMATE SHEET		QUANTITY		UNIT COST		MATERIAL COST		STD LABOR MM		SUBCONTRACT COST	
DESCRIPTION		REQ	EA	UNIT COST		MATERIAL COST		STD LABOR MM		SUBCONTRACT COST			
1	FA 504 SPENT CATALYST VESSEL	1											
2	5'-0" ID 15'-0" TT TK 30'-0" SKIRT HT												
3	mm <input type="checkbox"/>												
4	MAT C S CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4"												
5	DES PRESS + 8" WC 1/2" VAC DES TEMP 250 OF												
6	DES PRESS 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
7	X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
8	INTERNAL: CONE BOTTOM												
9	INSUL <input checked="" type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/>												
10	FA 10 ID TT TK 30'-0" SKIRT HT												
11	mm <input type="checkbox"/>												
12	MAT C S CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4"												
13	DES PRESS 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
14	X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
15	INTERNAL:												
16	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>												
17	FA 10 ID TT TK 30'-0" SKIRT HT												
18	mm <input type="checkbox"/>												
19	MAT C S CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4"												
20	DES PRESS 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
21	X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
22	INTERNAL:												
23	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>												
24	FA 10 ID TT TK 30'-0" SKIRT HT												
25	mm <input type="checkbox"/>												
26	MAT C S CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4"												
27	DES PRESS 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
28	X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
29	INTERNAL:												
30	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>												
TOTAL THIS PAGE													
TOTAL ACCOUNT													
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT		PROD FACT		LOC. M.H.		BY HLC.		JOB NO. 5571		ACCT FA			
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB. COST		DATE 11/25/87		EST		REV. 0			
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS													

CASE 1 MAXIMUM JP-4 500 AREA

THE LUMMUS COMPANY Bloomfield									
ESTIMATE SHEET									
DESCRIPTION									
QUANTITY		MATERIAL		UNIT		STD LABOR MH		SUBCONTRACT	
REQ	EA	COST	COST	UNIT	UNIT	UNIT	TOTAL	COST	COST
1	GA. 500A	CAT. TRANSFER PUMP							
2	GPM 10	SUCT	PSIG	DISCH	PSI	TEMP	600 OF		
3	m ³ /h	SUCT	PSIG	DISCH	PSI	TEMP	OC		
4	SP GR	ΔP	FT	2600	PSI	STGS			
5		ΔP	m			RPM			
6	MAT CASE	SS	IMPELLER			25	HP		
7	DRIVE EM -	<input checked="" type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER			kw		
8	TYPE CENT -	<input type="checkbox"/> RECIP	<input checked="" type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	<input type="checkbox"/> API	<input type="checkbox"/> ANSI			
9	MECH. SEAL	<input type="checkbox"/>							
10	INSUL	<input checked="" type="checkbox"/>	ERECT. WT. PUMP & DRIVER						
11	GA. 500A	CATALYST OIL PUMP							
12	GPM 10	SUCT	PSIG	DISCH	PSI	TEMP	200 OF		
13	m ³ /h	SUCT	PSIG	DISCH	PSI	TEMP	OC		
14	SP GR	ΔP	FT	250	PSI	STGS			
15		ΔP	m			RPM			
16	MAT CASE	CS	IMPELLER			3	HP		
17	DRIVE EM -	<input checked="" type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER			kw		
18	TYPE CENT -	<input checked="" type="checkbox"/> RECIP	<input type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	<input type="checkbox"/> API	<input type="checkbox"/> ANSI			
19	MECH. SEAL	<input checked="" type="checkbox"/>							
20	INSUL	<input checked="" type="checkbox"/>	ERECT. WT. PUMP & DRIVER						
21	GA.								
22	GPM	SUCT	PSIG	DISCH	PSI	TEMP	OF		
23	m ³ /h	SUCT	PSIG	DISCH	PSI	TEMP	OC		
24	SP GR	ΔP	FT		PSI	STGS			
25		ΔP	m			RPM			
26	MAT CASE		IMPELLER				HP		
27	DRIVE EM -	<input type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER			kw		
28	TYPE CENT -	<input type="checkbox"/> RECIP	<input type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	<input type="checkbox"/> API	<input type="checkbox"/> ANSI			
29	MECH. SEAL	<input type="checkbox"/>							
30	INSUL	<input type="checkbox"/>	ERECT. WT. PUMP & DRIVER						
TOTAL THIS PAGE									
TOTAL ACCOUNT									
CLIENT HILCO/DOE-GREAT PLAINS GASIF. PLANT									
LOCATION BEULAH, NORTH DAKOTA									
PROJECT JET FUELFROM COAL DERIVED LIQUIDS									
BY		DATE		REV.		JOB NO.		ACCT	
11/16		11/25/87		0		5571		GA	

6.0 EQUIPMENT DATA AND ESTIMATE SHEETS

6.2 Naphtha Stream

6.2.1 AREA 600

6.2.2 AREA 700

RR5571-6.TXT

AREA 600

CLIENT:DOE

PROJECT:5571

LOCATION:BEULAH,ND.

PROJECT:JET FUEL

DATE/BY:

22-Mar-89

08:57 AM

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

HEATERS

TOWERS

INTERNALS

REACTORS

EXCHANGERS

AIR COOLERS

VESSELS

TANKS

FILTERS

PUMPS

COMPRESSORS

PACKAGE UNITS

TOTAL

2	\$48	140%	\$67	
	\$8			
1	\$125	85%	\$106	
9	\$123	100%	\$123	
7	\$89	100%	\$89	
16	\$68	100%	\$68	
4	\$230	60%	\$138	
39	\$691		\$591	

SUMMARY

EQUIPMENT

\$691

COMMODITIES

\$591

LABOR

\$424 (10% EQUIP, 60% COMM)

INDIRECTS

\$424 (100% LABOR)

ENGINEERING

\$1,872 (800/PC X \$60)

SUBTOTAL

\$4,002

CONTINGENCY

\$800 (20%)

TOTAL

\$4,803

ESCALATION

\$600 12.5%

TOTAL

\$5,403

CASE 7 MAX PROFIT

600 AREA

THE LUMMUS COMPANY Bloomfield									
ESTIMATE SHEET									
DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST		
	REQ	EA			UNIT	TOTAL			
1 DA 601 NAPHTHA DISTIL. COLN									
2 2'-6" ID 50'-0" TT TK SKIRT HT	1								
3 m <input type="checkbox"/> mm <input type="checkbox"/>									
4 MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4" /									
5 DES PRESS 75 PSIG DES TEMP 325 °F									
6 DES PRESS 75 PSIG DES TEMP 325 °F									
7 X RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>									
8 INTERNALS TRAYS - INSTALLED SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>									
9									
10 INSUL <input checked="" type="checkbox"/> DA - lbs DB - lbs ERECT WT									
11 DA 602 HDT NAPHTHA STABILIZER									
12 2'-6" ID 32'-0" TT TK SKIRT HT	1								
13 m <input type="checkbox"/> mm <input type="checkbox"/>									
14 MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4" /									
15 DES PRESS 100 PSIG DES TEMP 325 °F									
16 DES PRESS 100 PSIG DES TEMP 325 °F									
17 X RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>									
18 INTERNALS TRAYS - INSTALLED SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>									
19									
20 INSUL <input checked="" type="checkbox"/> DA - lbs DB - lbs ERECT WT									
21 DA									
22 ID TT TK SKIRT HT									
23 m <input type="checkbox"/> mm <input type="checkbox"/>									
24 MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4" /									
25 DES PRESS 75 PSIG DES TEMP 325 °F									
26 DES PRESS 75 PSIG DES TEMP 325 °F									
27 X RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>									
28 INTERNALS TRAYS - INSTALLED SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>									
29									
30 INSUL <input type="checkbox"/> DA - lbs DB - lbs ERECT WT									
TOTAL THIS PAGE									
TOTAL ACCOUNT									
CLIENT Amoco/PAGE-GREAT PLAINS GASIF. PLANT								PROJ FACT	
LOCATION BEULAH, NORTH DAKOTA								WAGE RATE	
PROJECT JET FUEL FUEL COAD STABILIZER									
BY <u>RLC</u> JOB NO. <u>5571</u> ACCT									
DATE <u>4 JAN 86</u> EST									
REV <u>0</u>									

CASE 7 MAX PROFIT

600 AREA



THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

DESCRIPTION										QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
										REQ	EA			UNIT	TOTAL	
1	DB	601	NAPHTHA DISTILL. TRAYS													
2			TYPE	DIA	DIA m [] mm []	MAT	NO PASSES									
3			Value	2'-6"		CS	1			30		150-	4500			
4																
5																
6																
7																
8																
9			OTHER INTERNALS													
10																
11	DB	602	HDT NAPHTHA STABIL. TRAYS													
12			TYPE	DIA	DIA m [] mm []	MAT	NO PASSES									
13			Value	2'-6"		CS	1			18		150-	2700			
14																
15																
16																
17																
18																
19			OTHER INTERNALS													
20																
21	DB															
22			TYPE	DIA	DIA m [] mm []	MAT	NO PASSES									
23																
24																
25																
26																
27																
28																
29			OTHER INTERNALS													
30																
TOTAL THIS PAGE																
TOTAL ACCOUNT																

CLIENT	Amoco/DGE - GREAT PLAINS GASIF. PLANT	BY	HL	ACCT	
LOCATION	BEULAH, NORTH DAKOTA	DATE	4 JAN 88	JOB NO.	5571
PROJECT	ET FUEL FROM CALD LIPIDS	REV	0	EST	DB

CASE 7 MAX PROFIT

600 AREA



ESTIMATE WORKSHEET

LINE NO.	DESCRIPTION	QUANTITY		STD LABOR MH	LOCATION LABOR COST (1) x (2) x (3)	UNIT COST	MATERIAL COST	SUB. CONTRACT COST	TOTAL COST M + L + S/C
		AMOUNT	UNIT MEAS.						
1	DC - 601 HYDROTREATED RAZOR		No.						
2	4'0" ID 16'0" TIT IN SKIRT HT	23000	lbs. ea			5.00	125000		
3									
4	MAT'L C - 1/2" M-CLAD CA 1/4"								
5	DES PRESS 870 PSIG DES TEMP 525 OF								
6	X-RAY STRESS REL FAB SHOP/FIELD								
7	HORIZONTAL VERTICAL								
8	INTERNALS Catalyst, Bed Support								
9									
10									
11									
12									
13	INSUL - YES/NO ERECT WT -		tons ea						
14									
15	DC		No.						
16	ID TIT IN SKIRT HT		lbs. ea						
17									
18	MAT'L CLAD CA								
19	DES PRESS PSIG DES TEMP OF								
20	X-RAY STRESS REL FAB SHOP/FIELD								
21	HORIZONTAL VERTICAL								
22	INTERNALS								
23									
24									
25									
26	INSUL - YES/NO ERECT WT -		tons ea						
27									
28									
29	TOTAL THIS PAGE								
30	TOTAL ACCOUNT - DC								
31	CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT								
32	LOCATION BEULAH, NORTH DAKOTA								
33	PROJECT JET FULL FLOW CAL DEVID LIQUIDS								

BY ML JOB NO. 5571 ACCT DC
 DATE 4 JAN 88
 REV. 0

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SEE 7 MAX PROFIT 609 EA

THE LUMMUS COMPANY Bloomfield									
ESTIMATE SHEET									
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST		
		REQ	TOTAL			UNIT	TOTAL		
1	EA-601 NAPHTHA DISTIL. COLN REBOILER	1							
2	SIZE-IN DIL								
3	NO SHELL/SERV. 1 SO FT/SHELL 700 TOTAL SOFT 700 /SERV		1	SO FT	13000				
4	NO SHELL/SERV. m ² /SHELL TOTAL m ² /SERV			m ²					
5	SHELL SIDE C.A. mm TUBE SIDE C.A. mm								
6	MAT CS								
7	DES PRESS 85 PSIG								
8	DES TEMP 325 °F								
9	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT								
10	TUBE ENDS: WELDED NO. TUBES INSUL ERECT. WT								
11	EA-602 NAPHTHA DISTIL. COLN CONDENSER	1							
12	SIZE-IN DIL								
13	NO SHELL/SERV. 1 SO FT/SHELL 400 TOTAL SOFT 400 /SERV			SO FT	8000				
14	NO SHELL/SERV. m ² /SHELL TOTAL m ² /SERV			m ²					
15	SHELL SIDE C.A. mm TUBE SIDE C.A. mm								
16	MAT CS								
17	DES PRESS 75 PSIG								
18	DES TEMP 190 °F								
19	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT								
20	TUBE ENDS: WELDED NO. TUBES INSUL ERECT. WT								
21	EA-603 HDT REACTOR FEED/EFFL. EXCH.	1							
22	SIZE-IN DIL								
23	NO SHELL/SERV. 1 SO FT/SHELL 325 TOTAL SOFT 650 /SERV			SO FT	35000				
24	NO SHELL/SERV. m ² /SHELL TOTAL m ² /SERV			m ²					
25	SHELL SIDE C.A. mm TUBE SIDE C.A. mm								
26	MAT C-1/4" M12								
27	DES PRESS 870 PSIG								
28	DES TEMP 525 °F								
29	TUBES DIA GA MIN AV WELDED SMLS EXP JOINT								
30	TUBE ENDS: WELDED NO. TUBES INSUL ERECT. WT								
TOTAL THIS PAGE									
TOTAL ACCOUNT									
CLIENT AMOCO DOE-GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. M.H.		BY H/L.		JOB NO. 5571	
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB. COST		DATE 4 JAN 88		EST	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV. 0		EA	

C. E. 7 MAX PROFIT

600' EA

THE LUMMUS COMPANY
Bloomington



ESTIMATE SHEET

DESCRIPTION		QUANTITY		MATERIAL COST	UNIT COST	STD LABOR MM		SUBCONTRACT COST
		REQ	TOTAL			UNIT	TOTAL	
1 EA-604 HDT REACTOR RECYCLE GAS HEATER	TYPE AEU	1						
2 SIZE-IN DIL								
3 NO SHELL/SERV.	SO FT/SHELL 2000 TOTAL SOFT 2000 /SERV		50 FT	20-	76000			
4 NO SHELL/SERV.	m ² /SHELL TOTAL m ² /SERV		m ²					
5 SHELL SIDE C.A.	mm							
6 MAT	C-1/2 Mo							
7 DES PRESS	870 PSIG							
8 DES TEMP	475 °F							
9 TUBES DIA	GA MM							
10 TUBE ENDS: WELDED	INSUL							
11 EA-605 STABILIZER FEED EXCHANGER	TYPE AEU	1						
12 SIZE-IN DIL								
13 NO SHELL/SERV.	SO FT/SHELL 175 TOTAL SOFT 175 /SERV		50 FT	46-	7000			
14 NO SHELL/SERV.	m ² /SHELL TOTAL m ² /SERV		m ²					
15 SHELL SIDE C.A.	mm							
16 MAT	CS							
17 DES PRESS	870 PSIG							
18 DES TEMP	270 °F							
19 TUBES DIA	GA MM							
20 TUBE ENDS: WELDED	INSUL							
21 EA-606 REACTOR EFFLUENT COOLER	TYPE AEU	1						
22 SIZE-IN DIL								
23 NO SHELL/SERV.	SO FT/SHELL 350 TOTAL SOFT 350 /SERV		50 FT	85-	9000			
24 NO SHELL/SERV.	m ² /SHELL TOTAL m ² /SERV		m ²					
25 SHELL SIDE C.A.	mm							
26 MAT	CS							
27 DES PRESS	130 PSIG							
28 DES TEMP	120 °F							
29 TUBES DIA	GA MM							
30 TUBE ENDS: WELDED	INSUL							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT Amoco DOE-GREAT PLAINS GASIF. PLANT								
LOCATION BEULAH, NORTH DAKOTA								
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS								
BY H/L								
DATE 4 JAN 88								
REV. 0								
JOB NO. 5571								
ACCT EA								

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SE 7 MAX PROFIT 600 EA



ESTIMATE SHEET

THE LUMMUS COMPANY
Beaumont, Texas

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SURCONTRACT COST
REQ	TOTAL					UNIT	TOTAL	
1 EA-607 STABILIZER FEED HEATER								
SIZE-IN DIL		mm DIL		TYPE AES				
NO SHELL/SERV.		1		SO FT/SHELL 550		TOTAL SOFT 350		/SERV
NO SHELL/SERV.		1		m ² /SHELL		TOTAL m ²		/SERV
SHELL SIDE C.A.		1		mm		TUBE SIDE C.A.		mm
MAT		CS						
DES PRESS		120 PSIG		140 PSIG				
DES TEMP		300 OF		360 OF				
TUBES DIA		GA MIN		AV		WELDED		SMLS
TUBE ENDS: WELDED		NO. TUBES		INSUL		EXP JOINT		ERECT. WT
11 EA-608 NAPHTHA STABILIZER CONDENSER								
SIZE-IN DIL		mm DIL		TYPE AES				
NO SHELL/SERV.		1		SO FT/SHELL 350		TOTAL SOFT 350		/SERV
NO SHELL/SERV.		1		m ² /SHELL		TOTAL m ²		/SERV
SHELL SIDE C.A.		1		mm		TUBE SIDE C.A.		mm
MAT		CS						
DES PRESS		100 PSIG		130 PSIG				
DES TEMP		220 OF		120 OF				
TUBES DIA		GA MIN		AV		WELDED		SMLS
TUBE ENDS: WELDED		NO. TUBES		INSUL		EXP JOINT		ERECT. WT
21 EA-609 HPT NAPHTHA COOLER								
SIZE-IN DIL		mm DIL		TYPE AES				
NO SHELL/SERV.		1		SO FT/SHELL 200		TOTAL SOFT 200		/SERV
NO SHELL/SERV.		1		m ² /SHELL		TOTAL m ²		/SERV
SHELL SIDE C.A.		1		mm		TUBE SIDE C.A.		mm
MAT		CS						
DES PRESS		110 PSIG		130 PSIG				
DES TEMP		325 OF		120 OF				
TUBES DIA		GA MIN		AV		WELDED		SMLS
TUBE ENDS: WELDED		NO. TUBES		INSUL		EXP JOINT		ERECT. WT
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO PDE-GREAT PLAINS GASIF. PLANT				PROD. FACT		LOC. MH		ADCT
LOCATION BEULAH, NORTH DAKOTA				WAGE RATE		LAB. COST		EA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV. 0		BY HIL
						DATE 4/1/88		JOB NO. 5571
								EST

CASE 7 MAY PROFIT

600 AREA

THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
	REQ	EA			UNIT	TOTAL	
1 FA-601 CRUPE NAPHTHA FEED SURGE							
2 4'-0" ID 8'-0" TT TK 10'-0" SKIRT HT	1		3-	12000			
3 4'-0" ID 8'-0" TT TK 10'-0" SKIRT HT							
4 MAT CS CLAD Lining CA 1/4" 1							
5 DES PRESS 50 PSIG DES TEMP 170 OF							
6 DES PRESS 50 PSIG DES TEMP 170 OF							
7 X-RAY SPOT 100% STRESS REL FAB SHOP FIELD							
8 INTERNALS: VORTEX BREAKER							
9							
10 INSUL HORIZ VERT SPHERE			TONS				
11 FA-602 DISTIL. COLN REFLUX DRUM	1						
12 3'-0" ID 11'-0" TT TK SKIRT HT			3-	12000			
13 3'-0" ID 11'-0" TT TK SKIRT HT							
14 MAT CS CLAD Lining CA 1/4" 1							
15 DES PRESS 75 PSIG DES TEMP 170 OF							
16 DES PRESS 75 PSIG DES TEMP 170 OF							
17 X-RAY SPOT 100% STRESS REL FAB SHOP FIELD							
18 INTERNALS:							
19							
20 INSUL HORIZ VERT SPHERE			TONS				
21 FA-603 HDT FEED SURGE DRUM	1						
22 4'-0" ID 8'-0" TT TK 10'-0" SKIRT HT			3-	12000			
23 4'-0" ID 8'-0" TT TK 10'-0" SKIRT HT							
24 MAT CS CLAD Lining CA 1/4" 1							
25 DES PRESS 125 PSIG DES TEMP 325 OF							
26 DES PRESS 125 PSIG DES TEMP 325 OF							
27 X-RAY SPOT 100% STRESS REL FAB SHOP FIELD							
28 INTERNALS:							
29							
30 INSUL HORIZ VERT SPHERE			TONS				
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT							
LOCATION BEULAH, NORTH DAKOTA							
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS							
BY JLL							
DATE 1/15/86							
REV 0							
ACCT FA							
JOB NO. 5571							
EST							

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CASE 7 MAX PROFIT

600 AREA

ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield			
LINE	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST					
		REQ	EA			UNIT	TOTAL						
1	FA-604 MAKEUP GAS KO												
2	2'-0" ID 8'-0" TT	1											
3	mm <input type="checkbox"/>												
4	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4"												
5	DES PRESS 400												
6	DES PRESS												
7	X-RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
8	INTERNALS: De minimis												
9													
10	INSUL <input checked="" type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/>												
11	FA-605 HT/HP SEPARATOR												
12	10 TT												
13	mm <input type="checkbox"/>												
14	MAT DE CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA												
15	DES PRESS												
16	DES PRESS												
17	X-RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
18	INTERNALS:												
19													
20	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>												
21	FA-606 LT/HP SEPARATOR												
22	3'-6" ID 6'-6" TT												
23	mm <input type="checkbox"/>												
24	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4"												
25	DES PRESS 870												
26	DES PRESS												
27	X-RAY SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>												
28	INTERNALS: Baffle, Demister												
29													
30	INSUL <input checked="" type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>												
TOTAL THIS PAGE													
TOTAL ACCOUNT													
CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. M.H.		BY: HIL		JOB NO. 5571					
LOCATION BEULAH, NORTH DAKOTA		WAGER RATE		LAB. COST		DATE 4 JAN 88		ACCT FA					
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV. 0							

CASE 7 MAX PROFIT

600 AREA



LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

NO	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	FA 607 RECYCLE GAS KO							
2	2'-0" ID 8'-0" TT TK MIN. SKIRTH	1						
3	in <input type="checkbox"/> mm <input type="checkbox"/>							
4	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4" /							
5	DES PRESS 170 PSIG DES TEMP 170 °F							
6	DES PRESS 170 °F DES TEMP 170 °C							
7	X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
8	INTERNAL: Demister							
9								
10	INSUL <input checked="" type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/> ERECT WT							
11	FA 608 NAPHTHA STABIL. REFLUX							
12	3'-0" ID 11'-0" TT TK SKIRTH	1						
13	in <input type="checkbox"/> mm <input type="checkbox"/>							
14	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4" /							
15	DES PRESS 100 PSIG DES TEMP 170 °F							
16	DES PRESS 100 °F DES TEMP 100 °C							
17	X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
18	INTERNAL: Baffle, Boot, 16" ID x 20" IT							
19								
20	INSUL <input checked="" type="checkbox"/> HORIZ <input checked="" type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/> ERECT WT							
21	FA							
22	in <input type="checkbox"/> mm <input type="checkbox"/>							
23	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/4" /							
24	DES PRESS 100 PSIG DES TEMP 170 °F							
25	DES PRESS 100 °F DES TEMP 100 °C							
26	X-RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
27	INTERNAL:							
28								
29								
30	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/> ERECT WT							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT		PROD FACT		LOC M.H.		BY M.C.		ACCT
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB COST		DATE 1/18/88		FA
PROJECT JET FUEL FROM COAL DRYED LIQUIDS						REV 0		

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CAS 7 MAX PROFIT

600 AF



THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
	REQ	EA			UNIT	TOTAL	
1 GA 601A/S CRUDE NAPHTHA FEED	2			8000			
2 GPM 25							
3 m ³ /h							
4 SP GR							
5							
6 MAT CASE CS							
7 DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>							
8 TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
9 MECH SEAL <input checked="" type="checkbox"/>							
10 INSUL <input checked="" type="checkbox"/>							
11 GA 602A/S DISTIL. COLN BOTTOMS	2			8000			
12 GPM 18							
13 m ³ /h							
14 SP GR							
15							
16 MAT CASE CS							
17 DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>							
18 TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
19 MECH SEAL <input checked="" type="checkbox"/>							
20 INSUL <input checked="" type="checkbox"/>							
21 GA 603A/S DISTIL. COLN REFLUX	2			8000			
22 GPM 45							
23 m ³ /h							
24 SP GR							
25							
26 MAT CASE CS							
27 DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>							
28 TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
29 MECH SEAL <input checked="" type="checkbox"/>							
30 INSUL <input checked="" type="checkbox"/>							
TOTAL THIS PAGE							
TOTAL ACCOUNT							

CLIENT	ALLOGO/DOE - GREAT PLAINS GASIF. PLANT	BY	MLL	JOB NO.	5571	ACCT	GA
LOCATION	BEULAH, NORTH DAKOTA	DATE	4/24/88	EST			
PROJECT	JET FUEL FROM COAL DERIVED LIQUIDS	REV.	0				

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ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION										QUANTITY		MATERIAL COST		STD LABOR MH		SUBCONTRACT COST			
										REQ	EA	UNIT COST		UNIT	TOTAL				
1 GA 604A/S HDT FEED										2									
2	GPM	18	SUCT	PSIG	DISCH	PSI	TEMP	275°F											
3	m³/h		SUCT	SPR	DISCH	SPR	TEMP	°C											
4	SP GR		ΔP	FT	815	PSI	STGS												
5			ΔP	m		SPR	RPM												
6	MAT CASE			IMPELLER			30	HP											
7	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>			PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>			KW												
8	TYPE CENT - <input type="checkbox"/> RECIP <input checked="" type="checkbox"/>			OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>															
9	MECH SEAL <input type="checkbox"/>						ERECT WT PUMP & DRIVER		TONS										
10	INSUL <input checked="" type="checkbox"/>																		
11 GA 605A/S PROCESS WATER										2									
12	GPM	6	SUCT	PSIG	DISCH	PSI	TEMP	70	°F										
13	m³/h		SUCT	SPR	DISCH	SPR	TEMP	°C											
14	SP GR		ΔP	FT	710	PSI	STGS												
15			ΔP	m		SPR	RPM												
16	MAT CASE			IMPELLER			10	HP											
17	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>			PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>			KW												
18	TYPE CENT - <input type="checkbox"/> RECIP <input checked="" type="checkbox"/>			OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>															
19	MECH SEAL <input type="checkbox"/>						ERECT WT PUMP & DRIVER		TONS										
20	INSUL <input checked="" type="checkbox"/>																		
21 GA 606A/S HDT NAPHTHA										2									
22	GPM	20	SUCT	PSIG	DISCH	PSI	TEMP	275°F											
23	m³/h		SUCT	SPR	DISCH	SPR	TEMP	°C											
24	SP GR		ΔP	FT	30	PSI	STGS												
25			ΔP	m		SPR	RPM												
26	MAT CASE			IMPELLER			1	HP											
27	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>			PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>			KW												
28	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/>			OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>															
29	MECH SEAL <input checked="" type="checkbox"/>						ERECT WT PUMP & DRIVER		TONS										
30	INSUL <input checked="" type="checkbox"/>																		
TOTAL THIS PAGE																			
TOTAL ACCOUNT																			
CLIENT ALLILOGO/DOE-GREAT PLAINS GASIF. PLANT														BY	WLL	JOB NO.	5571	ACCT	GA
LOCATION BEULAH, NORTH DAKOTA														DATE	4 JAN 88	EST			
PROJECT TET FUEL FROM COAL DERIVED LIQUIDS														REV.	0				

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CA: 7 MAX PROFIT

600 A



ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

NO	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	GA 607A'S NARATHA STABIL-REFLEX	2			8000			
2	GPM 30							
3	PSIG DISCH							
4	TEMP 100 OF							
5	SP GR							
6	MAT CASE CS							
7	DRIVE EM - TURB DIESEL OTHER							
8	TYPE CENT - RECIP PROP OTHERS API ANSI							
9	MECH. SEAL							
10	INSUL							
11	GA 608A'S SOUL WATER	2			8000			
12	GPM 1/2							
13	PSIG DISCH							
14	TEMP 100 OF							
15	SP GR							
16	MAT CASE CS							
17	DRIVE EM - TURB DIESEL OTHER							
18	TYPE CENT - RECIP PROP OTHERS API ANSI							
19	MECH. SEAL							
20	INSUL							
21	GA							
22	GPM							
23	PSIG DISCH							
24	TEMP 100 OF							
25	SP GR							
26	MAT CASE							
27	DRIVE EM - TURB DIESEL OTHER							
28	TYPE CENT - RECIP PROP OTHERS API ANSI							
29	MECH. SEAL							
30	INSUL							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT ALCO/DOE-GREAT PLAINS GASIF. PLANT		LOC. M.H.		BY	DATE	REV.	JOB NO.	ACCT
LOCATION BEULAH, NORTH DAKOTA				MLL	4/5/1988	0	5571	GA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS		LAB. COST						

CA-67 MAX PROFIT

600 ARK



THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

LINE NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	GB 602A/B MAKEUP GAS COMPRESSOR	2						
2	CAP SCFM 146 STM PSIG				110.000			
3	MAT'L HANDLED 99.99% H ₂ 0.01% C ₁ 2.02 MW							
4	SUCT 340 PSIA/ 120 °F							
5	DISCH 840 PSIA/ 143 STGS /							
6	MAT. CASE CS IMPELLER VOLTS							
7	DRIVER EM TURB DIESEL 20 BHP / MW							
8	INCL. GEAR LUBE & SEAL INTERCOOLER COND							
9	TYPE CENT RECIP ROTARY SCREW							
10	INSUL ERECT WT. COMPR + DRIVE TONS							
11	GB 602A/B RECYCLE GAS COMPRESSOR	2			120.000			
12	CAP SCFM 1050 STM PSIG							
13	MAT'L HANDLED 95% H ₂ , 1% H ₂ S, 4% C ₁ 4.1 MW							
14	SUCT 105 PSIA/ 120 °F							
15	DISCH 840 PSIA/ 139 STGS /							
16	MAT. CASE CS IMPELLER VOLTS							
17	DRIVER EM TURB DIESEL 20 BHP / MW							
18	INCL. GEAR LUBE & SEAL INTERCOOLER COND							
19	TYPE CENT RECIP ROTARY SCREW							
20	INSUL ERECT WT. COMPR + DRIVE TONS							
21	GB							
22	CAP SCFM STM PSIG							
23	MAT'L HANDLED							
24	SUCT PSIA/ TEMP °F							
25	DISCH PSIA/ STGS							
26	MAT. CASE IMPELLER VOLTS							
27	DRIVER EM TURB DIESEL BHP / MW							
28	INCL. GEAR LUBE & SEAL INTERCOOLER COND							
29	TYPE CENT RECIP ROTARY SCREW							
30	INSUL ERECT WT. COMPR + DRIVE TONS							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO/DUE - GREAT PLAINS GAS F. PLANT		PROD FACT	LOC. M.H.	ACCT	JOB NO. 5571			
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE	LAB COST	GB	DATE 4 JAN 88			
PROJECT TEST PILLER & AL PERIODICALLY					REV 0			

AREA 700

CLIENT:DOE

PROJECT:5571

LOCATION:BEULAH,ND.

PROJECT:JET FUEL

DATE/BY:

22-Mar-89

09:08 AM

EQUIPMENT

PCS.

\$ EQUIP.

% COMM

\$ COMM

HEATERS

TOWERS

INTERNALS

REACTORS

EXCHANGERS

AIR COOLERS

VESSELS

TANKS

FILTERS

PUMPS

COMPRESSORS

PACKAGE UNITS

TOTAL

10	\$350	140%	\$490
	\$66		
20	\$113	100%	\$113
9	\$65	120%	\$78
7	\$117	100%	\$117
44	\$180	120%	\$216
		60%	
3	\$20	100%	\$20
93	\$911		\$1,034

SUMMARY

EQUIPMENT

\$911

COMMODITIES

\$1,034

LABOR

\$712 (10% EQUIP, 60% COMM)

INDIRECTS

\$712 (100% LABOR)

ENGINEERING

\$4,464 (800/PC X \$60)

SUBTOTAL

\$7,832

CONTINGENCY

\$1,566 (20%)

TOTAL

\$9,398

ESCALATION

\$940

10.0%

TOTAL

\$10,338

C. 10 E 7 MAX PROFIT

700 AREA



THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

NO	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	DA 701 EXTRACTOR COLUMN	1						
2	2'-6" ID 109'-0" TT TK 5'-0" SKIRT HT		18,000 LBS	250	45,000			
3	<input type="checkbox"/> mm <input type="checkbox"/>							
4	MAT. CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" mm							
5	DES PRESS 150 8-7/8" PSIG DES TEMP 250 °F							
6	DES PRESS 150 8-7/8" PSIG DES TEMP 250 °C							
7	X RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>							
8	INTERNAL TRAYS-INSTALLED SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
9	INSUL <input checked="" type="checkbox"/> DA- 104 DB- 104 ERECT WT. TONS							
10	DA 702 RAFFINATE WATER WASH COLUMN	1						
11	1'-6" ID 60'-0" TT TK 5'-0" SKIRT HT		6,000 LBS	4-	24,000			
12	<input type="checkbox"/> mm <input type="checkbox"/>							
13	MAT. CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" mm							
14	DES PRESS 135 8-7/8" PSIG DES TEMP 250 °F							
15	DES PRESS 135 8-7/8" PSIG DES TEMP 250 °C							
16	X RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>							
17	INTERNAL TRAYS-INSTALLED SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
18	INSUL <input type="checkbox"/> DA- 104 DB- 104 ERECT WT. TONS							
19	DA 703 STRIPPER	1						
20	2'-9" ID 83'-0" TT TK 19'-0" SKIRT HT		15,000 LBS	250	38,000			
21	<input type="checkbox"/> mm <input type="checkbox"/>							
22	MAT. CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" mm							
23	DES PRESS 50 PSIG DES TEMP 400 °F							
24	DES PRESS 50 PSIG DES TEMP 400 °C							
25	X RAY SPOT <input type="checkbox"/> 100% STRESS REL <input type="checkbox"/> FAB SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>							
26	INTERNAL TRAYS-INSTALLED SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
27	INSUL <input checked="" type="checkbox"/> DA- 104 DB- 104 ERECT WT. TONS							
28	TOTAL THIS PAGE							
29	TOTAL ACCOUNT							
30	CLIENT AMOCO/DUG-GRATE PLAINS GASIF. PLANT							
	LOCATION BEULAH, NORTH DAKOTA							
	PROJECT JET FUEL FROM COWD DERIVED LIQUIDS							

BY ML JOB NO. 5571 ACCT
DATE 12/18/87 EST
REV. 0 DA

CASE 7 MAX PROFIT

700 AREA

LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	DA-704 RECOVERY COLUMN							
2	3'-0" ID 112'-0" TT TK 18'-0" SKIRT HT	1						
3	mm		29,000 LBS	250	58,000			
4	MAT C.S. CLAD Lining CA 1/8"							
5	DES PRESS 50 PSIG DES TEMP 400 °F							
6	DES PRESS 100% STRESS REL FAB-SHOP FIELD							
7	INTERNAL TRAYS-INSTALLED SHOP FIELD							
8	INSUL DA DB 1/8" ERECT WT							
9	TONS							
10	DA-705 WATER STRIPPER							
11	1'-6" ID 20'-0" TT TK - SKIRT HT	1						
12	mm		3,000 LBS	4-	12,000			
13	MAT C.S. CLAD Lining CA 1/8"							
14	DES PRESS 50 PSIG DES TEMP 310 °F							
15	DES PRESS 100% STRESS REL FAB-SHOP FIELD							
16	INTERNAL TRAYS-INSTALLED SHOP FIELD							
17	FLANGED BOTH ENDS, TOP MM COVER							
18	INSUL DA DB 1/8" ERECT WT							
19	TONS							
20	DA-706 SOLVENT REGENERATOR							
21	1'-9" ID 15'-0" TT TK 6'-0" SKIRT HT	1						
22	mm		3,000 LBS	4-	12,000			
23	MAT C.S. CLAD Lining CA 1/8"							
24	DES PRESS 50 PSIG DES TEMP 400 °F							
25	DES PRESS 100% STRESS REL FAB-SHOP FIELD							
26	INTERNAL TRAYS-INSTALLED SHOP FIELD							
27	EA-710 THRU SHELL, INLET DIATRIB, 6" WAPOL MESH							
28	INSUL DA DB 1/8" ERECT WT							
29	TONS							
30	TOTAL THIS PAGE							
	TOTAL ACCOUNT							
CLIENT AMOCO/NOB-GREAT PLAINS GASIF. PLANT		PROD FACT	LOC. M.H.	BY	DATE	REV.	JOB NO.	ACCT
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE	LAB COST	ML	12/18/87	0	5571	DA
PROJECT JET FUEL FROM WAPOL DERIVED LIQUIDS								

CASE 7 MAX PROFIT

700 AREA

LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	DA 707A/B CLAY TOWERS							
2	2'-6" ID 28'-0" TT TK 10'-0" SKIRT HT	2	14,000 LBS EACH	3-	16,000			
3	3" mm							
4	MAT. C.S. CLAD Lining CA 1/8" mm							
5	DES PRESS 365 PSIG DES TEMP 450 °F							
6	DES PRESS 365 PSIG DES TEMP 450 °F							
7	X-RAY SPOT 100% STRESS REL FAB-SHOP FIELD							
8	INTERNAL TRAYS-INSTALLED SHOP FIELD							
9								
10	INSUL DA DB- 100 ERECT WT TONS							
11	DA 708 BENZENE COLUMN	1						
12	3'-6" ID 130'-0" TT TK 15'-6" SKIRT HT		25,000 LBS	2-	50,000			
13	3" mm							
14	MAT. C.S. CLAD Lining CA 1/8" mm							
15	DES PRESS 50 PSIG DES TEMP 360 °F							
16	DES PRESS 50 PSIG DES TEMP 360 °F							
17	X-RAY SPOT 100% STRESS REL FAB-SHOP FIELD							
18	INTERNAL TRAYS-INSTALLED SHOP FIELD							
19								
20	INSUL DA DB- 100 ERECT WT TONS							
21	DA 709 TOLUENE COLUMN	1						
22	2'-0" ID 111'-0" TT TK 15'-0" SKIRT HT		15,000 LBS	3-	45,000			
23	3" mm							
24	MAT. C.S. CLAD Lining CA 1/8" mm							
25	DES PRESS 50 PSIG DES TEMP 390 °F							
26	DES PRESS 50 PSIG DES TEMP 390 °F							
27	X-RAY SPOT 100% STRESS REL FAB-SHOP FIELD							
28	INTERNAL TRAYS-INSTALLED SHOP FIELD							
29								
30	INSUL DA DB- 100 ERECT WT TONS							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO/DUG-GREAT PLAINS GASIF. PLANT		BY ML		JOB NO. 5571		ACCT DA		
LOCATION BEULAH, NORTH DAKOTA		DATE 12/18/87		EST				
PROJECT JET FUEL FROM GUAD DERIVED LIQUIDS		REV		G				

CASE 7 MAX PROFIT

700 AREA

THE LUMMUS COMPANY

Bloomfield

ESTIMATE SHEET

DESCRIPTION

NO.	TYPE	DIA	DIA m	mm	MATERIAL	NO. PASSES	QUANTITY	REQ	EA	UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST
												UNIT	TOTAL
1	DB 701	EXTRACTOR TRAYS											
2	STILLING TRAY	2'-6"			CS	2	1			50	14000		
3	RAIN DECK	2'-6"			CS	2	94			150			
4													
5													
6													
7													
8													
9	OTHER INTERNALS: 6" OF GRATINGS IN 8TH., VORTEX BRK												
10										TONS			
11	DB 702	RAFFINATE WATER WITH TRAYS											
12													
13	Liq-LIQ. CONTACTING	1'-6"			CS	2	6			75	1000		
14	FEED TRAY	1'-6"			CS	2	1			75			
15													
16													
17													
18													
19	OTHER INTERNALS: 4" OF GRATINGS IN 8TH., FEED DISTRIB.												
20										TONS			
21	DB 703	STRIPPED TRAYS											
22													
23	VALVE	2'-9"			CS	2	30			50	5000		
24													
25													
26													
27													
28	OTHER INTERNALS: REBOLLER TRAPOUT, INLET DISTRIB.												
29										TONS			
30	TOTAL THIS PAGE												
TOTAL ACCOUNT										LOC. M.H.		JOB NO. 5571	
CLIENT: AMOCO/BOB-GREAT PLAINS SAFETY PLANT										LAB. COST		BY: ML	
LOCATION: BEULAH, NORTH DAKOTA										WAGERATE		DATE: 12/14/87	
PROJECT: FUEL FROM COAL DERIVED LIQUIDS										ACCT DB		REV: 0	

CASE 7 MAX PROFIT

700 AREA



THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

DESCRIPTION										QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
										REQ	EA			UNIT	TOTAL	
DB-704 RECOVERY COLUMN TRAYS																
1	TYPE	DIA	DIA m	mm	MAT	NO	PASSES									
2	VALVE	3'-0"			CS	1			15			150	5000			
3	VALVE	3'-0"			CS	2			18			150				
4	TRAPS	3'-0"			CS				5			-				
5	COLLECTORS	3'-0"			CS				2				3000			
6	LIQUID DISTRIBUTOR	3'-0"			CS				1							
OTHER INTERNALS: VORTEX 8KA.																
EA-705 IN SHELL.											TONS					
DB-705 WATER STRIPPER TRAYS																
1	TYPE	DIA	DIA m	mm	MAT	NO	PASSES									
2	VALVE (TYPE)	1'-6"			CS				5			75	1000			
3																
4																
5																
6																
7																
8																
OTHER INTERNALS:											TONS					
TOTAL THIS PAGE											TONS					
TOTAL ACCOUNT																
CLIENT AMCO/DOE - GREAT PLAINS SASIF. PLANT										PROD. FACT		LOC. MH.	BY: M/L	JOB NO. 5571	ACCT	
LOCATION BEULAH, NORTH DAKOTA										WAGE RATE		LAB. COST	DATE 12/18/87	EST	DB	
PROJECT FUEL FROM COAL DERIVED LIQUIDS													REV			

CASE 7 MAX PROFIT

700 AREA

THE LUMARUS COMPANY

ESTIMATE SHEET

Bloomfield

DESCRIPTION										QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST	
										REQ	EA			UNIT	TOTAL		
1	DB 707A18 CLAY TOWER PACKING																
2	TYPE	DIA	DIA m	mm	MAT.	NO. PASSES											
3	SCREENED SILICA SAND	20 FT 3															
4	CLAY - FILTERED 424	240 FT 3															
5		+ 120 FT 3 STAKE CHARGE															
6																	
7																	
8																	
9	OTHER INTERNALS: 4 - 6" SECTIONS OF WIRE MESH,																
10	CERAMIC BALLS IN BTH, FEED DISTRIBUTOR. ERECT. WT.											TONS					
11	DB 708 BENZENE COLUMN TRAYS																
12	TYPE	DIA	DIA m	mm	MAT.	NO. PASSES											
13	VALVE	3'-6"			CS	1						200					
14																	
15																	
16																	
17																	
18																	
19	OTHER INTERNALS:																
20												TONS					
21	DB 709 TOLUENE COLUMN TRAYS																
22	TYPE	DIA	DIA m	mm	MAT.	NO. PASSES											
23	VALVE	2'-0"			CS	1						100					
24	TRAP	2'-0"			CS	1						100					
25																	
26																	
27																	
28																	
29	OTHER INTERNALS:																
30												TONS					
TOTAL THIS PAGE																	
TOTAL ACCOUNT																	
CLIENT AMOCO/BOB - GREAT PLAINS SAFI. PLANT																	
LOCATION BEULAH - NORTH DAKOTA																	
PROJECT SET FUEL FROM CALDERIVED LIQUIDS																	
											PROD. FACT						
											WAGE RATE						
											LOC. M.H.						
											LAB. COST						
											BY	ML					
											DATE	12/1/77					
											REV						
											JOB NO.	5571					
											EST						
											ACCT						
											DB						

C 5 E 7 MAX PROFIT

7000 A

E LUMINUS

ESTIMATE SHEET

THE LUMINUS COMPANY
Bloomfield

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MIN	SUBCONTRACT COST
REQ	TOTAL	UNIT	TOTAL				
1 EA-701 RAFFINATE COOLER							
TYPE DOUBLE PIPE							
SIZE-IN. D/L	50 FT/SHELL	TOTAL SOFT	50	/SERV			
NO SHELL/SERV.	1	TOTAL m ²			100	5000	
NO SHELL/SERV.	1	TOTAL m ²					
SHELL SIDE C.A.	mm	TUBE SIDE C.A.	mm				
MAAT	C.S.						
DES PRESS	130 PSIG	DES PRESS	130 PSIG				
DES TEMP	250 °F	DES TEMP	175 °F				
TUBES DIA	3/4 GA MIN	AV	WELDED	SMLS	EXP JOINT		
TUBE ENDS: WELDED	INSUL						
11 EA-702 LEAN/RICH SOLVENT EXCHANGER							
TYPE AES							
SIZE-IN. D/L	50 FT/SHELL	TOTAL SOFT	50	/SERV			
NO SHELL/SERV.	2	TOTAL m ²			20	11000	
NO SHELL/SERV.	1	TOTAL m ²					
SHELL SIDE C.A.	mm	TUBE SIDE C.A.	mm				
MAAT	C.S.						
DES PRESS	150 PSIG	DES PRESS	310 PSIG				
DES TEMP	280 °F	DES TEMP	340 °F				
TUBES DIA	3/4 GA MIN	AV	WELDED	SMLS	EXP JOINT		
TUBE ENDS: WELDED	INSUL						
21 EA-703 STRIPPER REBOILER							
TYPE NEN							
SIZE-IN. D/L	50 FT/SHELL	TOTAL SOFT	230	/SERV			
NO SHELL/SERV.	1	TOTAL m ²			20	5000	
NO SHELL/SERV.	1	TOTAL m ²					
SHELL SIDE C.A.	mm	TUBE SIDE C.A.	mm				
MAAT	C.S.						
DES PRESS	75 PSIG	DES PRESS	635 PSIG				
DES TEMP	400 °F	DES TEMP	775 °F				
TUBES DIA	3/4 GA MIN	AV	WELDED	SMLS	EXP JOINT		
TUBE ENDS: WELDED	INSUL						
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT				BY M/L		JOB NO. 5571	
LOCATION BEULAH, NORTH DAKOTA				DATE 12/18/87		EA	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS				REV.			

A122 (0816) REV. 2

C. E 7 MAX PROFIT

7000A



ESTIMATE SHEET

THE LUMMUS COMPANY
Bismarck, ND

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR UNIT		SUBCONTRACT COST
		REQ	TOTAL			UNIT	TOTAL	
1	EA-704 STRIPPER CONDENSER	1						
2	SIZE-IN. DIL							
3	NO SHEL/SERV. /							
4	NO SHEL/SERV. /							
5	SHELL SIDE C.A. /							
6	MAAT /							
7	DES PRESS /							
8	DES TEMP /							
9	TUBES DIA 3/4 GA MIN /							
10	TUBE ENDS: WELDED /							
11	EA-705 RECOVERY COLUMN REBOILER	1						
12	SIZE-IN. DIL							
13	NO SHEL/SERV. /							
14	NO SHEL/SERV. /							
15	SHELL SIDE C.A. /							
16	MAAT /							
17	DES PRESS /							
18	DES TEMP /							
19	TUBES DIA 3/4 GA MIN /							
20	TUBE ENDS: WELDED /							
21	EA-706 RECOVERY COLUMN INTER. REBOILER	1						
22	SIZE-IN. DIL							
23	NO SHEL/SERV. /							
24	NO SHEL/SERV. /							
25	SHELL SIDE C.A. /							
26	MAAT /							
27	DES PRESS /							
28	DES TEMP /							
29	TUBES DIA 3/4 GA MIN /							
30	TUBE ENDS: WELDED /							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO DOW-GREAT PLAINS GASIF. PLANT								
LOCATION BEULAH, NORTH DAKOTA								
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS								
BY M.L.								
DATE 12/18/72								
REV. 0								
JOB NO. 5571								
ACCT EA								

A172 1081-6 REV. 2

CA-37 MAX PROFIT

700

THE LUMMUS COMPANY
(Incorporated)

ESTIMATE SHEET

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
REQ	TOTAL	UNIT	TOTAL			UNIT	TOTAL	
1 EA-707 RECOVERY COLUMN CONDENSER TYPE AES								
1	1							
2 SIZE IN. D/L		30 FT/SHELL		SO FT				
3 NO SHELL/SERV. 1		TOTAL SO FT 723 /SERV		m ²	13000			
4 NO SHELL/SERV.		TOTAL m ² /SERV						
5 SHELL SIDE C.A. 1		TUBE SIDE C.A. 1						
6 MAT CS		CS						
7 DES PRESS 75 PSIG		130 PSIG						
8 DES TEMP 250 °F		175 °F						
9 TUBES DIA 3/4" GA MIN		AV WELDED SMLS EXP JOINT						
10 TUBE ENDS: WELDED NO. TUBES INSUL		ERECT WT						
11 EA-708 RECOVERY COLUMN EJECTOR CAND. TYPE AES								
12 SIZE IN. D/L		30 FT/SHELL		SO FT				
13 NO SHELL/SERV. 1		TOTAL SO FT 50 /SERV		m ²	6000			
14 NO SHELL/SERV.		TOTAL m ² /SERV						
15 SHELL SIDE C.A. 1		TUBE SIDE C.A. 1						
16 MAT CS		CS						
17 DES PRESS 75 PSIG		130 PSIG						
18 DES TEMP 250 °F		175 °F						
19 TUBES DIA 3/4" GA MIN		AV WELDED SMLS EXP JOINT						
20 TUBE ENDS: WELDED NO. TUBES INSUL		ERECT WT						
21 EA-709 WATER STRIPPER REBOILER TYPE BKU (MOD)								
22 SIZE IN. D/L		30 FT/SHELL		SO FT				
23 NO SHELL/SERV. 1		TOTAL SO FT 140 /SERV		m ²	10000			
24 NO SHELL/SERV.		TOTAL m ² /SERV						
25 SHELL SIDE C.A. 1		TUBE SIDE C.A. 1						
26 MAT CS		CS						
27 DES PRESS 75 PSIG		310 PSIG						
28 DES TEMP 300 °F		400 °F						
29 TUBES DIA 3/4" GA MIN		AV WELDED SMLS EXP JOINT						
30 TUBE ENDS: WELDED NO. TUBES INSUL		ERECT WT						
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO / DOE - GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. M.H.		BY M/L	JOB NO. 5571	ACCT EA
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB. COST		DATE 12/18/87	EST	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV.		

A172 1081-0 REV. 2

C. E. 7 MAX PROFIT

70071A

THE LUMMUS COMPANY Bloomfield									
ESTIMATE SHEET									
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM	SUBCONTRACT COST		
REQ	TOTAL					UNIT	TOTAL		
1 EA-710 SOLVENT REGENERATOR REBOILER									
SIZE-IN. DIA	mm DIA	TYPE	SHAGGED-IN 8-U						
NO SHELL/SERV.	1	SO FT/SHELL	TOTAL SOFT 10 /SERV		35000				
NO SHELL/SERV.		m ² /SHELL	TOTAL m ² /SERV						
SHELL SIDE C.A.		mm	TUBE SIDE C.A.						
MAT		COLUMN	CS (FINNED 74E)						
DES PRESS	PSIG	mm ²	635 PSIG						
DES TEMP	°F	°C	775 °F						
TUBES DIA 3/4 GA MM		AV	WELDED	SMLS	EXP JOINT				
TUBE ENDS: WELDED		NO. TUBES	INSUL		ERECT. WT				
11 EA-711 SOLVENT COOLER									
SIZE-IN. DIA	mm DIA	TYPE	AES						
NO SHELL/SERV.	1	SO FT/SHELL	TOTAL SOFT 186 /SERV		20-				
NO SHELL/SERV.		m ² /SHELL	TOTAL m ² /SERV						
SHELL SIDE C.A.		mm	TUBE SIDE C.A.						
MAT		CS	CS						
DES PRESS	310 PSIG	mm ²	130 PSIG						
DES TEMP	400 °F	°C	175 °F						
TUBES DIA 3/4 GA MM		AV	WELDED	SMLS	EXP JOINT				
TUBE ENDS: WELDED		NO. TUBES	INSUL		ERECT. WT				
21 EA-712 CLAY THR. FEED/EFFL. EXCHANGER									
SIZE-IN. DIA	mm DIA	TYPE	AES						
NO SHELL/SERV.	1	SO FT/SHELL	TOTAL SOFT 75 /SERV						
NO SHELL/SERV.		m ² /SHELL	TOTAL m ² /SERV						
SHELL SIDE C.A.		mm	TUBE SIDE C.A.						
MAT		CS	CS						
DES PRESS	365 PSIG	mm ²	365 PSIG						
DES TEMP	360 °F	°C	430 °F						
TUBES DIA 3/4 GA MM		AV	WELDED	SMLS	EXP JOINT				
TUBE ENDS: WELDED		NO. TUBES	INSUL		ERECT. WT				
TOTAL THIS PAGE									
TOTAL ACCOUNT									
CLIENT AMOCO DUE-GREAT PLAINS GASIF. PLANT				PROD. FACT		WAGE RATE		ACCT	
LOCATION BEULAH, NORTH DAKOTA				LOC. M.H.		LAB. COST		JOB NO. 5571	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS								EST	
								REV. 0	
								DATE 12/18/87	
								EA	

C. J. E 7 MAX PROFIT

7000 A

LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bismarck

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	TOTAL			UNIT	TOTAL	
1 EA-713 CLAY TOWER FEED HEATER	TYPE DOUBLE PIPE	1						
2 SIZE-IN. D/L	mm D/L							
3 NO SHELL/SERV.	SO FT/SHELL		SO FT					
4 NO SHELL/SERV.	m ² /SHELL		m ²		2000			
5 SHELL SIDE C.A.	mm							
6 MAT	C/S							
7 DES PRESS	470 PSIG							
8 DES TEMP	450 °F							
9 TUBES DIA	GA MIN							
10 TUBE ENDS: WELDED	NO. TUBES							
11 EA-714 BENZENE COLUMN REBOILER	TYPE BCU	1						
12 SIZE-IN. D/L	mm D/L							
13 NO SHELL/SERV.	SO FT/SHELL		SO FT	25-	5000			
14 NO SHELL/SERV.	m ² /SHELL		m ²					
15 SHELL SIDE C.A.	mm							
16 MAT	C/S							
17 DES PRESS	75 PSIG							
18 DES TEMP	360 °F							
19 TUBES DIA	GA MIN							
20 TUBE ENDS: WELDED	NO. TUBES							
21 EA-715 BENZENE PRODUCT COOLER	TYPE DOUBLE PIPE	1						
22 SIZE-IN. D/L	mm D/L							
23 NO SHELL/SERV.	SO FT/SHELL		SO FT		2000			
24 NO SHELL/SERV.	m ² /SHELL		m ²					
25 SHELL SIDE C.A.	mm							
26 MAT	C/S							
27 DES PRESS	100 PSIG							
28 DES TEMP	250 °F							
29 TUBES DIA	GA MIN							
30 TUBE ENDS: WELDED	NO. TUBES							
TOTAL THIS PAGE								
TOTAL ACCOUNT								

CLIENT	AMOCO/D&E-GREAT PLAINS GASIF. PLANT	BY	ML	JOB NO.	5571	ACCT	
LOCATION	BEULAH, NORTH DAKOTA	DATE	12/18/87	EST			EA
PRODUCT	JET FUEL FROM COAL DERIVED LIQUIDS	REV.	0				

A172 1081-8 REV. 1

C. 67 MAX PROFIT

700



ESTIMATE SHEET

THE LUMMUS COMPANY
Broomfield

ITEM	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	TOTAL			UNIT	TOTAL	
1	EA 716 BENZENE COLUMN CONDENSER							
2	SIZE-IN DIL							
3	NO SHELL/SERV. 1 50 FT/SHELL							
4	NO SHELL/SERV. TOTAL SO FT 475 /SERV							
5	SHELL SIDE C.A. 1 mm							
6	MAAT CS							
7	DES PRESS 75 PSIG							
8	DES TEMP 250 OF							
9	TUBES DIA 3/4 GA MIN AV WELDED SMLS EXP JOINT							
10	TUBE ENDS: WELDED NO. TUBES INSL							
11	EA 717 TOLUENE COLUMN REBOILER							
12	SIZE-IN DIL							
13	NO SHELL/SERV. 1 50 FT/SHELL							
14	NO SHELL/SERV. TOTAL SO FT 70 /SERV							
15	SHELL SIDE C.A. 1 mm							
16	MAAT CS							
17	DES PRESS 75 PSIG							
18	DES TEMP 390 OF							
19	TUBES DIA 3/4 GA MIN AV WELDED SMLS EXP JOINT							
20	TUBE ENDS: WELDED NO. TUBES INSL							
21	EA 718 XYLENE PRODUCT COOLER							
22	SIZE-IN DIL							
23	NO SHELL/SERV. 1 50 FT/SHELL							
24	NO SHELL/SERV. TOTAL SO FT 55 /SERV							
25	SHELL SIDE C.A. 1 mm							
26	MAAT CS							
27	DES PRESS 75 PSIG							
28	DES TEMP 390 OF							
29	TUBES DIA 3/4 GA MIN AV WELDED SMLS EXP JOINT							
30	TUBE ENDS: WELDED NO. TUBES INSL							
TOTAL THIS PAGE								
TOTAL ACCOUNT								

CLIENT: AMOCO DOE-GREAT PLAINS GASIF. PLANT
LOCATION: BEULAH, NORTH DAKOTA
PROJECT: JET FUEL FROM COAL DERIVED LIQUIDS

BY: MLC
DATE: 12/15/87
REV: 0

LOC. M.H.
LAB. COST

PROD. FACT
WAGE RATE

JOB NO. 5571
ACTY
EA

C.C.E 7 MAX PROFIT

700

LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
(Incorporated)

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	TOTAL			UNIT	TOTAL	
1	EA-719 TOLUENE COLUMN CONDENSER							
2	SIZE-IN. D/L							
3	NO SHELL/SERV. 1		SO FT		5000			
4	NO SHELL/SERV.		m ²					
5	SHELL SIDE C.A.		TUBE SIDE C.A.					
6	MAT							
7	DES PRESS 75 PSIG							
8	DES TEMP 305 °F							
9	TUBES DIA 3/4 GA MIN							
10	TUBE ENDS: WELDED <input type="checkbox"/> NO. TUBES <input type="checkbox"/> INSUL <input type="checkbox"/>							
11	EA-720 TOLUENE PRODUCT COOLER							
12	SIZE-IN. D/L							
13	NO SHELL/SERV. 1		SO FT		3000			
14	NO SHELL/SERV.		m ²					
15	SHELL SIDE C.A.		TUBE SIDE C.A.					
16	MAT							
17	DES PRESS 150 PSIG							
18	DES TEMP 250 °F							
19	TUBES DIA GA MIN							
20	TUBE ENDS: WELDED <input type="checkbox"/> NO. TUBES <input type="checkbox"/> INSUL <input type="checkbox"/>							
21	EA							
22	SIZE-IN. D/L							
23	NO SHELL/SERV.		SO FT					
24	NO SHELL/SERV.		m ²					
25	SHELL SIDE C.A.		TUBE SIDE C.A.					
26	MAT							
27	DES PRESS PSIG							
28	DES TEMP °F							
29	TUBES DIA GA MIN							
30	TUBE ENDS: WELDED <input type="checkbox"/> NO. TUBES <input type="checkbox"/> INSUL <input type="checkbox"/>							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO DOE-GREAT PLAINS GASIF. PLANT								
LOCATION BEULAH, NORTH DAKOTA								
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS								
		PROD. FACT	WAGE RATE	LOC. M.M.	LAB. COST	BY	JOB NO. 5571	ACCT
						DATE 12/11/87	EST	EA
						REV.		

A122 1081-6 REV. 2

CASE 7 MAX PROFIT

700 AREA

THE LUMMUS COMPANY Bloomfield		ESTIMATE SHEET		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
DESCRIPTION		REQ	EA	UNIT	TOTAL					
1	FA 701 FEED SURGE DRUM									
2	2'-6" ID 8'-0" TT TK MIN. SKIRT HT	1								
3	mm									
4	MAT C S. CLAD Lining CA									
5	DES PRESS 50 PSIG DES TEMP 250 °F									
6	DES PRESS 50 PSIG DES TEMP 250 °C									
7	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD									
8	INTERNALS: VORTEX BKK.									
9										
10	INSUL HORIZ VERT SPHERE									
11	FA 702 STRIPPER REFLUX DRUM	1								
12	1'-6" ID 11'-0" TT TK SKIRT HT									
13	mm									
14	MAT C S. CLAD Lining CA 1/8"									
15	DES PRESS 50 PSIG DES TEMP 250 °F									
16	DES PRESS 50 PSIG DES TEMP 250 °C									
17	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD									
18	INTERNALS: DIPLES & VORTEX BKK.									
19	18" x 2'-6" BOOT									
20	INSUL HORIZ VERT SPHERE									
21	FA 703 RECOVERY COLUMN REFLUX DRUM	1								
22	1'-6" ID 20'-0" TT TK SKIRT HT									
23	mm									
24	MAT C S. CLAD Lining CA 1/8"									
25	DES PRESS 50 PSIG DES TEMP 250 °F									
26	DES PRESS 50 PSIG DES TEMP 250 °C									
27	X-RAY SPOT 100% STRESS REL FAB SHOP FIELD									
28	INTERNALS: DIPLES & VORTEX BKK.									
29	18" x 2'-6" T-T BOOT									
30	INSUL HORIZ VERT SPHERE									
TOTAL THIS PAGE										
TOTAL ACCOUNT										
CLIENT AMOCO DOE - GREAT PLAINS GASIF. PLANT						PROD. FACT		WAGE RATE		ACCT
LOCATION BEULAH, NORTH DAKOTA						LOC. M.H.		LAB. COST		FA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						BY HLL		JOB NO. 5571		7
						DATE 12/14/87		REV.		

CASE 7 MAX PROFIT

700 AREA



ESTIMATE SHEET

THE LUMARUS COMPANY
(Incorporated)

DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
	REQ	EA			UNIT	TOTAL	
1 FA 704 EJECTOR CONDENSATE DRUM							
2 1'-6" ID 4'-0" TT TK SKIRT HT	1						
3 1" <input type="checkbox"/> mm		1000 LBS	4-	4000			
4 MAT CS CLAD <input type="checkbox"/> LINING CA 1/8" /							
5 DES PRESS 50 PSIG DES TEMP 250 OF							
6 DES PRESS 50 PSIG DES TEMP 250 OF							
7 X-RAY-SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB-SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>							
8 INTERNALS: 3 BAFFLES, INT. PIPE DISTRIB.							
9							
10 INSUL <input checked="" type="checkbox"/> HORIZ <input checked="" type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/> ERECT. WT.		TONS					
11 FA 705 SOLVENT SUMP							
12 8'-0" ID 6'-0" TT TK SKIRT HT	1						
13 1" <input type="checkbox"/> mm		2000 LBS	2-	4000			
14 MAT CS CLAD <input type="checkbox"/> LINING CA 1/8" /							
15 DES PRESS 50 PSIG DES TEMP 400 OF							
16 DES PRESS 50 PSIG DES TEMP 400 OF							
17 X-RAY-SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB-SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>							
18 INTERNALS: LEVEL BUBBLER, 3'-0" ID NECK 2'-T-T							
19 CURTAIN AND WRAPPED FOR BURIAL.							
20 INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/> ERECT. WT.		TONS					
21 FA 706 VENT K ₀ DRUM							
22 2'-0" ID 10'-0" TT TK 5'-0" SKIRT HT	1						
23 1" <input type="checkbox"/> mm		2000 LBS	4-	8000			
24 MAT CS CLAD <input type="checkbox"/> LINING CA 1/8" /							
25 DES PRESS 50 PSIG DES TEMP 425 OF							
26 DES PRESS 50 PSIG DES TEMP 425 OF							
27 X-RAY-SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB-SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>							
28 INTERNALS:							
29 HORIZONTAL BOTTOM 1/2							
30 INSUL <input checked="" type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/> SPHERE <input type="checkbox"/> ERECT. WT.		TONS					
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT AMOCO / DOE - GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY HIL.	JOB NO. 5571	ACCT FA		
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 12/15/47	EST			
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV. 0				

A172 10R18 REV. 2

CASE 7 MAX PROFIT

700 AREA



ESTIMATE SHEET

THE LUMMAUS COMPANY
Bismarck, N.D.

LINE NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	FA							
2	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>							
3	4'-0" ID 17'-0" TT TK	1		8000 LBS	250			
4	SKIRT HT							
5	MAT							
6	CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA							
7	DES PRESS							
8	DES PRESS							
9	X-RAY-SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
10	INTERNAL:							
11	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>							
12	FA 708 BENZENE COLN REFLUX DRUM							
13	4'-0" ID 17'-0" TT TK	1		8000 LBS	250			
14	SKIRT HT							
15	MAT							
16	CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8"							
17	DES PRESS							
18	DES PRESS							
19	X-RAY-SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
20	INTERNAL:							
21	WITH 18'x2' TITAN AND DIPPIPE							
22	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>							
23	FA 709 TOLUENE COLN REFLUX DRUM							
24	2'-0" ID 7'-0" TT TK	1		2000 LBS	4-			
25	SKIRT HT							
26	MAT							
27	CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8"							
28	DES PRESS							
29	DES PRESS							
30	X-RAY-SPOT <input type="checkbox"/> 100% <input type="checkbox"/> STRESS REL <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>							
31	INTERNAL: DIPPIPE							
32	INSUL <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/> SPHERE <input type="checkbox"/>							
33	ERECT. WT.							
34	TOTAL THIS PAGE							
35	TOTAL ACCOUNT							
36	CLIENT AMOCO DOE-GREAT PLAINS GASIF. PLANT							
37	LOCATION BEULAH, NORTH DAKOTA							
38	PROJECT JET FUEL FROM COAL DERIVED LIQUIDS							
39	PROD. FACT							
40	WAGE RATE							
41	LOC. M.H.							
42	LAB. COST							
43	BY 11/11							
44	DATE 12/18/87							
45	REV							
46	JOB NO. 5571							
47	EST							
48	ACCT							
49	FA							

CASE 7 MAX PROFIT

700 AREA

RE LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

LINE NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MM		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	701 SOLVENT STORAGE TANK	1						
2	13'-0" ID 13'-0" TT TK — SKIRT HT							
3	mm <input type="checkbox"/>							
4	MAT CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" mm							
5	DES PRESS ATMOS PSIG DES TEMP 120 °F							
6	DES PRESS kg/cm ² DES TEMP °C							
7	CAPACITY: 300 BARRELS GALLONS M ³			100				30,000
8	INTERNALS HEATING COIL							
9	TYPE: CR <input type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>							
10	INSUL <input checked="" type="checkbox"/> API <input type="checkbox"/> BULLETT <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input type="checkbox"/> ERECT. WT. TONS							
11	702 WET SOLVENT STORAGE TANK	1						
12	9'-0" ID 9'-0" TT TK — SKIRT HT							
13	mm <input type="checkbox"/>							
14	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" mm							
15	DES PRESS ATMOS PSIG DES TEMP 120 °F							
16	DES PRESS kg/cm ² DES TEMP °C			150	15,000			
17	CAPACITY: 100 BARRELS GALLONS M ³							
18	INTERNALS HEATING COIL							
19	TYPE: CR <input type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>							
20	INSUL <input checked="" type="checkbox"/> API <input type="checkbox"/> BULLETT <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input type="checkbox"/> ERECT. WT. TONS							
21	703 CLAY TOWER SURGE TANK	1						
22	12'-6" ID 12'-0" TT TK — SKIRT HT							
23	mm <input type="checkbox"/>							
24	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8" mm							
25	DES PRESS ATMOS PSIG DES TEMP 120 °F							
26	DES PRESS kg/cm ² DES TEMP °C			100				25,000
27	CAPACITY: 250 BARRELS GALLONS M ³							
28	INTERNALS							
29	TYPE: CR <input type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>							
30	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLETT <input type="checkbox"/> FAB-SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/> ERECT. WT. TONS							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. M.H.		BY M.L.		ACCT FB
LOCATION BEULAH, NORTH DAKOTA		WAGERATE		LAB. COST		DATE 1/11/87		JOB NO. 5571
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV. 0		

CASE 7 MAX PROFIT

700 AHA



ESTIMATE SHEET

THE LUMMUS COMPANY
Broomfield

DESCRIPTION		QUANTITY	UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST
REQ	EA				UNIT	TOTAL
1	FB-704 BENZENE DAY TANK					
2	13'-6" ID 13'-0" TT TK					
3	mm					
4	MAT CS CLAD LING CA 1/8"					
5	DES PRESS ATMOS PSIG DES TEMP 120 OF					
6	DES PRESS kg/cm ² DES TEMP °C					
7	CAPACITY: 320 BARRELS GALLONS		100			32000
8	INTERNAL					
9	TYPE: CR <input type="checkbox"/> FR <input checked="" type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>					
10	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB-SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>					
11	FB-705 XYLENE DAY TANK					
12	4'-0" ID 7'-0" TT TK					
13	mm					
14	MAT CS CLAD LING CA 1/8"					
15	DES PRESS ATMOS PSIG DES TEMP 120 OF		200	3000		
16	DES PRESS kg/cm ² DES TEMP °C					
17	CAPACITY: 15 BARRELS GALLONS					
18	INTERNAL					
19	TYPE: CR <input type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/>					
20	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB-SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>					
21	FB-706A18 TOLUENE DAY TANKS					
22	9'-0" ID 9'-0" TT TK					
23	mm		100	12000		
24	MAT CS CLAD LING CA 1/8"					
25	DES PRESS ATMOS PSIG DES TEMP 120 OF					
26	DES PRESS kg/cm ² DES TEMP °C					
27	CAPACITY: 120 BARRELS GALLONS					
28	INTERNAL					
29	TYPE: CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>					
30	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB-SHOP <input checked="" type="checkbox"/> FIELD <input type="checkbox"/>					
TOTAL THIS PAGE						
TOTAL ACCOUNT						
CLIENT AMOCO/DGE-GREAT PLAINS GASIF. PLANT					BY M.L.	JOB NO. 5571
LOCATION BEULAH, NORTH DAKOTA			LOC. M.H.		DATE 12/18/87	EST FB
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			LAB. COST		REV. 0	

GA-7 MAX PROFIT

700 AN

THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL
GA-701A1S FEED CHARGE PUMP							
1	GPM 15	2					
2	PSIG DISCH						
3	TEMP 100 °F						
4	PSIG DISCH						
5	TEMP °C						
6	FT 160						
7	PSI						
8	STGS						
9	RPM						
10	2 1/2 H.P.						
11	IMPELLER C.I.						
12	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>						
13	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>						
14	MECH. SEAL <input checked="" type="checkbox"/>						
15	ERECT WT. PUMP & DRIVER						
16	TONS						
GA-702A1S PUMPAROUND PUMP							
17	GPM 1	2					
18	PSIG DISCH						
19	TEMP 100 °F						
20	PSIG DISCH						
21	TEMP °C						
22	FT 50						
23	PSI						
24	STGS						
25	RPM						
26	1/2 H.P.						
27	IMPELLER C.S.						
28	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>						
29	TYPE CENT - <input type="checkbox"/> RECIP <input type="checkbox"/> PROP <input checked="" type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>						
30	MECH. SEAL <input type="checkbox"/>						
31	ERECT WT. PUMP & DRIVER						
32	TONS						
GA-703A1S RAFFINATE PUMP							
33	GPM 2	2					
34	PSIG DISCH						
35	TEMP 100 °F						
36	PSIG DISCH						
37	TEMP °C						
38	FT 50						
39	PSI						
40	STGS						
41	RPM						
42	1/2 H.P.						
43	IMPELLER C.S.						
44	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>						
45	TYPE CENT - <input type="checkbox"/> RECIP <input type="checkbox"/> PROP <input checked="" type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>						
46	MECH. SEAL <input type="checkbox"/>						
47	ERECT WT. PUMP & DRIVER						
48	TONS						
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT				BY <i>ML</i>		JOB NO. 5571	
LOCATION BEULAH, NORTH DAKOTA				DATE 12/15/57		ACCT GA	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS				REV. 0			

CASE 7 MAX PROFIT

700 ARL

LUMMUS		ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield	
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST					
		REQ	EA			UNIT	TOTAL						
1	GA-704A FS STRIPPER BOTTOMS PUMP	2											
2	GPM 80												
3	SUCT 20 PSIG DISCH												
4	ΔP FT 50												
5	ΔP												
6	MAT: CASE CS IMPELLER CI												
7	DRIVE EM - TURB DIESEL OTHER												
8	TYPE CENT - RECIP PROP OTHERS API ANSI												
9	MECH SEAL												
10	INSUL												
11	GA-705A FS STRIPPER WATER PUMP	2											
12	GPM 2												
13	SUCT 5 PSIG DISCH												
14	ΔP FT 50												
15	ΔP												
16	MAT: CASE CS IMPELLER CS												
17	DRIVE EM - TURB DIESEL OTHER												
18	TYPE CENT - RECIP PROP OTHERS API ANSI												
19	MECH SEAL												
20	INSUL												
21	GA-706A FS EXTRACTOR RECYCLE PUMP	2											
22	GPM 15												
23	SUCT 5 PSIG DISCH												
24	ΔP FT 135												
25	ΔP												
26	MAT: CASE CS IMPELLER CI												
27	DRIVE EM - TURB DIESEL OTHER												
28	TYPE CENT - RECIP PROP OTHERS API ANSI												
29	MECH SEAL												
30	INSUL												
TOTAL THIS PAGE													
TOTAL ACCOUNT													
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. M.H.		LAB. COST		BY ML		JOB NO. 5571			
LOCATION DEULAH, NORTH DAKOTA		WAGE RATE		DATE 12/18/87		REV.		ACCT GA					
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS													

CASE 7 MAX PROFIT

700 A.M.



ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
	REQ	EA			UNIT	TOTAL	
GA-709A'S LEAN SOLVENT PUMP							
1 GA-709A'S LEAN SOLVENT PUMP	2						
2 GPM 6.5				11.000			
3 SUCT 5 PSIG DISCH 100 PSI TEMP 345 OF							
4 SUCT 100 PSI DISCH 100 PSI TEMP 345 OF							
5 SP-GR 200 PSI STGS							
6 MAT: CASE C.S. IMPELLER C.S. 15 H.P.							
7 DRIVE EM - TURB DIESEL OTHER							
8 TYPE CENT - RECIP PROP OTHERS API ANSI							
9 MECH. SEAL							
10 INSUL							
GA-709A'S WASH WATER PUMP							
11 GA-709A'S WASH WATER PUMP	2			8.000			
12 GPM 3							
13 SUCT -5 PSIG DISCH 100 PSI TEMP 100 OF							
14 SUCT 100 PSI DISCH 100 PSI TEMP 100 OF							
15 SP-GR 100 PSI STGS							
16 MAT: CASE C.S. IMPELLER C.S. 1/2 H.P.							
17 DRIVE EM - TURB DIESEL OTHER							
18 TYPE CENT - RECIP PROP OTHERS API ANSI							
19 MECH. SEAL							
20 INSUL							
GA-709A'S RECOVERY COAL WHD PUMP							
21 GA-709A'S RECOVERY COAL WHD PUMP	2			8.000			
22 GPM 2.5							
23 SUCT -5 PSIG DISCH 100 PSI TEMP 100 OF							
24 SUCT 100 PSI DISCH 100 PSI TEMP 100 OF							
25 SP-GR 100 PSI STGS							
26 MAT: CASE C.S. IMPELLER C.S. 2 1/2 H.P.							
27 DRIVE EM - TURB DIESEL OTHER							
28 TYPE CENT - RECIP PROP OTHERS API ANSI							
29 MECH. SEAL							
30 INSUL							
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT				BY ML		JOB NO. 5571	
LOCATION DEULAH, NORTH DAKOTA				DATE 17/11/87		EST	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS				REV. G		ACCT GA	

CASE 7 MTH PROFIT

700 A.H.A.



ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION										QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST	
										REQ	EA			UNIT	TOTAL	
1 GA-710A'S WATER STRIPPER BTH'S PUMP										2			8,000			
2	GPM	2	SUCT	10	PSIG	DISCH	PSI	TEMP	251 OF							
3	m ³ /h		SUCT		PSIG	DISCH	PSI	TEMP	OC							
4	SP-GR		ΔP		FT		15	PSI	STGS							
5			ΔP		m			PSI	RPM							
6	MAT: CASE		CS		IMPELLER		CS		1/2 H.P.							
7	DRIVE EM -	<input checked="" type="checkbox"/>	TURB	<input type="checkbox"/>	DIESEL	<input type="checkbox"/>	OTHER	<input type="checkbox"/>	KW							
8	TYPE CENT -	<input type="checkbox"/>	RECIP	<input type="checkbox"/>	PROP	<input checked="" type="checkbox"/>	OTHERS	<input type="checkbox"/>	ANSI	<input type="checkbox"/>						
9	MECH. SEAL	<input type="checkbox"/>														
10	INSUL	<input checked="" type="checkbox"/>	ERECT. WT. PUMP & DRIVER										TONS			
11 GA-711A'S EJECTOR CONDENSATE										2			8,000			
12	GPM	1	SUCT	-5	PSIG	DISCH	PSI	TEMP	100 OF							
13	m ³ /h		SUCT		PSIG	DISCH	PSI	TEMP	OC							
14	SP-GR		ΔP		FT		50	PSI	STGS							
15			ΔP		m			PSI	RPM							
16	MAT: CASE		CS		IMPELLER		CS		1/2 H.P.							
17	DRIVE EM -	<input checked="" type="checkbox"/>	TURB	<input type="checkbox"/>	DIESEL	<input type="checkbox"/>	OTHER	<input type="checkbox"/>	KW							
18	TYPE CENT -	<input type="checkbox"/>	RECIP	<input type="checkbox"/>	PROP	<input checked="" type="checkbox"/>	OTHERS	<input type="checkbox"/>	ANSI	<input type="checkbox"/>						
19	MECH. SEAL	<input type="checkbox"/>														
20	INSUL	<input type="checkbox"/>	ERECT. WT. PUMP & DRIVER										TONS			
21 GA-712 SOLVENT TRANSFER PUMP										1			4,200			
22	GPM	50	SUCT	0	PSIG	DISCH	PSI	TEMP	100 OF							
23	m ³ /h		SUCT		PSIG	DISCH	PSI	TEMP	OC							
24	SP-GR		ΔP		FT		100	PSI	STGS							
25			ΔP		m			PSI	RPM							
26	MAT: CASE		CS		IMPELLER		CI		5 H.P.							
27	DRIVE EM -	<input checked="" type="checkbox"/>	TURB	<input type="checkbox"/>	DIESEL	<input type="checkbox"/>	OTHER	<input type="checkbox"/>	KW							
28	TYPE CENT -	<input checked="" type="checkbox"/>	RECIP	<input type="checkbox"/>	PROP	<input type="checkbox"/>	OTHERS	<input type="checkbox"/>	ANSI	<input type="checkbox"/>						
29	MECH. SEAL	<input checked="" type="checkbox"/>														
30	INSUL	<input type="checkbox"/>	ERECT. WT. PUMP & DRIVER										TONS			
TOTAL THIS PAGE																
TOTAL ACCOUNT																
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT										PROD. FACT		LOC. M.H.		BY ML	JOB NO. 5571	ACCT GA
LOCATION BEULAH, NORTH DAKOTA										WAGE RATE		LAB. COST		DATE 12/18/87	EST	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS														REV.		

CASE 7 MAX PROFIT

700 ARD

THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

LINE NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	GA-713 WET SOLVENT PUMP	1			7.00			
2	GPM 20							
3	PSIG DISCH							
4	PSIG DISCH							
5	FT							
6	PSI							
7	IMPELLER							
8	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>							
9	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
10	MECH. SEAL <input checked="" type="checkbox"/>							
11	GA-714AEB SOLVENT SUMP PUMP IMPELLER SUMP	2			8.00			
12	GPM 50							
13	PSIG DISCH							
14	PSIG DISCH							
15	FT							
16	PSI							
17	IMPELLER							
18	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>							
19	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
20	MECH. SEAL <input checked="" type="checkbox"/>							
21	GA-715AJS CLAY TOWER FEED PUMP	2			8.00			
22	GPM 10							
23	PSIG DISCH							
24	PSIG DISCH							
25	FT							
26	PSI							
27	IMPELLER							
28	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>							
29	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
30	MECH. SEAL <input checked="" type="checkbox"/>							
31	IMPELLER							
32	TOTAL THIS PAGE							
33	TOTAL ACCOUNT							
34	CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT							
35	LOCATION DEULAH, NORTH DAKOTA							
36	PROJECT JET FUEL FROM COAL DERIVED LIQUIDS							
37	BY ML							
38	DATE 12/18/87							
39	REV. 0							
40	JOB NO. 5571							
41	ACCT GA							

CASE 7 MAX PROFIT

700 AR.



ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

NO.	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	GA-716A'S BEURENE COLN BTHS PUMP	2			5000			
2	GPM 15 SUCT 15 PSIG DISCH PSI TEMP 300 OF							
3	m ³ /h SUCT SUCT h _{PC} /m ² DISCH h _{PC} /m ² TEMP °C							
4	SP-GR ΔP FT 40 PSI STGS							
5	ΔP m h _{PC} /m ² RPM							
6	MAT. CASE CS IMPELLER CI 1 HP							
7	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/> KW							
8	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
9	MECH. SEAL <input checked="" type="checkbox"/>							
10	INSUL <input checked="" type="checkbox"/> ERECT. WT. PUMP & DRIVER TONS							
11	GA-717A'S BENZENE COLN REFLUX PUMP	2			8000			
12	GPM 50 SUCT 5 PSIG DISCH PSI TEMP 140 OF							
13	m ³ /h SUCT SUCT h _{PC} /m ² DISCH h _{PC} /m ² TEMP °C							
14	SP-GR ΔP FT 85 PSI STGS							
15	ΔP m h _{PC} /m ² RPM							
16	MAT. CASE CS IMPELLER CI 5 HP							
17	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/> KW							
18	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
19	MECH. SEAL <input checked="" type="checkbox"/>							
20	INSUL <input type="checkbox"/> ERECT. WT. PUMP & DRIVER TONS							
21	GA-718A'S BENZENE COLN WATER PUMP	2			8000			
22	GPM 10 SUCT 10 PSIG DISCH PSI TEMP 140 OF							
23	m ³ /h SUCT SUCT h _{PC} /m ² DISCH h _{PC} /m ² TEMP °C							
24	SP-GR ΔP FT 45 PSI STGS							
25	ΔP m h _{PC} /m ² RPM							
26	MAT. CASE CS IMPELLER CS 1/2 HP							
27	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/> KW							
28	TYPE CENT - <input type="checkbox"/> RECIP <input type="checkbox"/> PROP <input checked="" type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
29	MECH. SEAL <input type="checkbox"/>							
30	INSUL <input type="checkbox"/> ERECT. WT. PUMP & DRIVER TONS							
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO/DIES-GREAT PLAINS GASIF. PLANT		PROD. FACT	LOC. M.H.	BY ML	JOB NO. 5571	ADCT		
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE	LAB. COST	DATE 11/28/82	EST	GA		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS		REV.						

C.A. 7 MAX PROFIT

7000



ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST
REQ	EA					UNIT	TOTAL
10A 719A15 BENZENE PRODUCT PUMP							
2	GPM	60	SUCT	0	PSIG	DISCH	TEMP 100 OF
3	m ³ /h		SUCT		PSIG	DISCH	TEMP 0 C
4	SP GR		ΔP		FT		STGS
5			ΔP		m		RPM
6	MAT CASE	CS	IMPELLER	CI			5 HP
7	DRIVE EM -	<input checked="" type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER			KW
8	TYPE CENT -	<input checked="" type="checkbox"/> RECIP	<input type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	API	<input type="checkbox"/> ANSI	
9	MECH SEAL	<input checked="" type="checkbox"/>					
10	INSUL	<input type="checkbox"/>					
ERECT WT PUMP & DRIVER							
2							8000
11 GA 720A15 TOLUENE COLN BIAS PUMP							
12	GPM	7	SUCT	15	PSIG	DISCH	TEMP 330 OF
13	m ³ /h		SUCT		PSIG	DISCH	TEMP 0 C
14	SP GR		ΔP		FT		STGS
15			ΔP		m		RPM
16	MAT CASE	CS	IMPELLER	CS			1/2 HP
17	DRIVE EM -	<input checked="" type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER			KW
18	TYPE CENT -	<input checked="" type="checkbox"/> RECIP	<input type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	API	<input type="checkbox"/> ANSI	
19	MECH SEAL	<input checked="" type="checkbox"/>					
20	INSUL	<input checked="" type="checkbox"/>					
ERECT WT PUMP & DRIVER							
2							8000
21 GA 721A15 TOLUENE COLN REFLUX PUMP							
22	GPM	20	SUCT	5	PSIG	DISCH	TEMP 200 OF
23	m ³ /h		SUCT		PSIG	DISCH	TEMP 0 C
24	SP GR		ΔP		FT		STGS
25			ΔP		m		RPM
26	MAT CASE	CS	IMPELLER	CI			2 HP
27	DRIVE EM -	<input checked="" type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER			KW
28	TYPE CENT -	<input checked="" type="checkbox"/> RECIP	<input type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	API	<input type="checkbox"/> ANSI	
29	MECH SEAL	<input checked="" type="checkbox"/>					
30	INSUL	<input checked="" type="checkbox"/>					
ERECT WT PUMP & DRIVER							
2							TONS
TOTAL THIS PAGE							
TOTAL ACCOUNT							
CLIENT ALLOGO/DUE-GREAT PLAINS GASIF. PLANT							
LOCATION BEULAH, NORTH DAKOTA							
PROJECT JET FUEL FROM CAL. HEAVY LIQUIDS							
BY <u>MLL</u> JOB NO. <u>5571</u> ACCT GA							
DATE <u>17/11/87</u> EST							
REV. <u>0</u>							

700 A

EE LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION										QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
										REQ	EA			UNIT	TOTAL	
GA-722AYS XYLENE PRODUCT PUMP										2			5000			
1	GPM	7	SUCT	0	PSIG	DISCH	PSI	TEMP	100 OF							
2	m ³ /h		SUCT		AP ^a _{kg/cm²}	DISCH	AP ^a _{kg/cm²}	TEMP	OC							
3			ΔP	FT	85	PSI		STGS								
4	SP-GR		ΔP	m		AP ^a _{kg/cm²}		RPM								
5																
6	MAT CASE															
7	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>															
8	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>															
9	MECH SEAL <input checked="" type="checkbox"/>															
10	INSUL <input type="checkbox"/>															
ERECT WT PUMP & DRIVER											TONS					
GA723AYS TOLUENE PRODUCT PUMP										2			5000			
11	GPM	25	SUCT	0	PSIG	DISCH	PSI	TEMP	100 OF							
12	m ³ /h		SUCT		AP ^a _{kg/cm²}	DISCH	AP ^a _{kg/cm²}	TEMP	OC							
13			ΔP	FT	85	PSI		STGS								
14	SP-GR		ΔP	m		AP ^a _{kg/cm²}		RPM								
15																
16	MAT CASE															
17	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>							2 1/2	H P							
18	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>															
19	MECH SEAL <input checked="" type="checkbox"/>															
20	INSUL <input type="checkbox"/>															
ERECT WT PUMP & DRIVER											TONS					
GA																
21	GPM		SUCT		PSIG	DISCH	PSI	TEMP	OF							
22	m ³ /h		SUCT		AP ^a _{kg/cm²}	DISCH	AP ^a _{kg/cm²}	TEMP	OC							
23			ΔP	FT		PSI		STGS								
24	SP-GR		ΔP	m		AP ^a _{kg/cm²}		RPM								
25																
26	MAT CASE															
27	DRIVE EM - <input type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>															
28	TYPE CENT - <input type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>															
29	MECH SEAL <input type="checkbox"/>															
30	INSUL <input type="checkbox"/>															
ERECT WT PUMP & DRIVER											TONS					
TOTAL THIS PAGE																

CASE 1 MAX FILIPIT

DESIGN COMPUTATIONS FOR AMOCO/DUE

JOB 5571 ACCT. _____

MISCELLANEOUS

FD-701 LEAN SOLVENT FILTER.

CAPACITY - 65 GPM OF SOLVENT

ΔP = 2 PSI CLEAN 15 PSI DIRTY

$$DP = 3.0 \text{ Pr/s} \quad DT = 2570 \text{ c/s}$$

PARTICLE REMOVAL - 50 MICRONS & LARGER

\$5,000

EE-701 EJECTORS - TWO REQ'D

HP STM FLOW - 100 [°]HR.

TO REDUCT 400 #/HR VAPOR FROM 5 PSIA TO 16 PSIA

DP = 635 PSIG DT = 775 °F

5,000

PA-761 CLAY HANDLING EQUIPMENT

1 LEADING HOPPER

LOT CANVAS HOSE (~200F)

1 LOADING CHUTE

15,000

[illegible]

A106 03 0776-1 REV.1

6.0 EQUIPMENT DATA AND ESTIMATE SHEETS

6.3 Phenol Stream

6.3.1 AREA 800

6.3.2 AREA 850

6.3.3 AREA 900

AREA 800

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571

DATE/BY: 21-Mar-89
 08:46 AM

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>				
<u>TOWERS</u>	5	\$776	100%	\$776
<u>INTERNALs</u>		\$143	0%	\$0
<u>REACTORS</u>			90%	\$0
<u>EXCHANGERS</u>	14	\$332	100%	\$332
<u>VESSELS</u>	9	\$73	120%	\$88
<u>TANKS</u>	3	\$53	80%	\$42
<u>FILTERS</u>				\$0
<u>PUMPS</u>	52	\$440	100%	\$440
<u>COMPRESSORS</u>				
<u>PACKAGE UNITS</u>	7	\$165	70%	\$115
<u>TOTAL</u>	90	\$1,982		\$1,794

SUMMARY

<u>EQUIPMENT</u>	\$1,982
<u>COMMODITIES</u>	\$1,794
<u>LABOR</u>	\$1,274 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$1,274 (100% LABOR)
<u>ENGINEERING</u>	<u>\$3,600 (800/PC X \$50)</u>
<u>SUBTOTAL</u>	\$9,924
<u>CONTINGENCY</u>	<u>\$1,985 (20%)</u>
<u>TOTAL</u>	\$11,909

EQUIPMENT SUMMARY

DA-801 FLASH COLUMN
DA-802 DRYER
DA-803 PHENOL COLUMN
DA-804 STRIPPING COLUMN
DA-805 LIGHT ENDS COLUMN

WEIGHT	MATL.	\$/LB	\$
72000	CS CLAD	\$3.00	\$216,000
9000	CS CLAD	\$4.50	\$40,500
123000	CS CLAD	\$3.00	\$369,000
33000	CS CLAD	\$3.50	\$115,500
7000	CS CLAD	\$5.00	\$35,000

TOTAL \$776,000

FT2	MATL.	\$/FT2	\$
2200	CS/SS VA	\$18.00	\$39,600
125		\$20.00	\$2,500
4500		\$18.00	\$81,000
1000		\$18.00	\$18,000
110		\$20.00	\$2,200

TOTAL

\$

TOTAL

\$143,300

EQUIPMENT SUMMARY

	FT2	MATL.	\$/FT2	\$
EA-801 FLASH COL COND.	1195	CS/CS	\$15.00	\$17,925
EA-802 FLASH COL REBOIL	4455	CS/316	\$26.25	\$116,944
EA-803 DEPHENOLTIZED CRESYLIC ACID COOLER	140	316/316	\$135.00	\$18,900
EA-804 FLASH COL TRIM COOL.	390	CS/CS	\$23.00	\$8,970
EA-805 DRYER CONDENSER	530	CS/CS	\$19.00	\$10,070
EA-806 PHENOL COL REBOIL	1480	CS/316	\$35.00	\$51,800
EA-807 PHENOL COL COND	1730	CS/CS	\$14.00	\$24,220
EA-808 LT. ENDS COL COND	345	CS/CS	\$23.00	\$7,935
EA-809 LT. ENDS COL REBOIL	150	CS/316	\$122.50	\$18,375
EA-810 STRIPPING COL COND	1050	CS/CS	\$16.00	\$16,800
EA-811 STRIPPING COL REBOIL	105	316/316	\$122.50	\$12,863
EA-812 PHENOL COOLER	90	316/316	\$122.50	\$11,025
EA-813 TAR COOLER	175	CS/CS	\$40.00	\$7,000
EA-814 STRIPPING COL SIDE REBOIL	450	CS/CS	\$20.00	\$9,000
			TOTAL	\$331,826

EQUIPMENT SUMMARY

FA-801	FLASH COL REFLUX DRUM	2000	CS	\$3.50	\$7,000
FA-802	DRYER COL	3000	CS	\$2.75	\$8,250
FA-803	PHENOL COL REFLUX DRUM	4000	CS	\$2.25	\$9,000
FA-804	STRIPPING COL REFLUX DRUM	1000	CS	\$4.00	\$4,000
FA-805	LT. ENDS COL REFLUX DRUM	1000	CS	\$4.00	\$4,000
FA-806	CRUDE PHENOL SURGE DRUM	16000	CS	\$1.50	\$24,000
FA-807	CRYSYLIC ACID DRUM	1000	CS	\$4.00	\$4,000
FA-808	PHENOL DRAWOFF DRUM	1000	CS	\$4.00	\$4,000
FA-809	LT. ENDS DRUM	4000	CS	\$2.25	\$9,000

TOTAL \$73,250

\$/BBL \$

BARRELS MATL.

FB-801	SULFURIC ACID DAY TANK	90	CS	\$90.00	\$8,100
FB-802	TAR DAY TANK	576	CS	\$40.00	\$23,040
FB-803	PHENOL DAY TANK	440	CS	\$50.00	\$22,000

\$53,140

EQUIPMENT SUMMARY

	HP	MATL.	\$/HP	\$
GA-801, CRUDE PHENOL PUMP	<10hp	CS	-----	\$15,000
GA-802, FLASH COL REFLUX	<10hp	CS	-----	\$15,000
GA-803, FLASH COL BTM.	<10hp	CS	-----	\$15,000
GA-804, ACID TAR	<10hp	CS	-----	\$15,000
GA-805, FLASH COL WATER	<10hp	CS	-----	\$15,000
GA-806, LT. ENDS COL FEED	<10hp	CS	-----	\$15,000
GA-807, SULFURIC ACID	<10hp	CS	-----	\$15,000
GA-808, CRESYLIC ACID	<10hp	CS	-----	\$15,000
GA-809, LT. ENDS COL REFLUX	<10hp	CS	-----	\$15,000
GA-819, LT. ENDS COL BTMS	<10hp	CS	-----	\$15,000
GA-811, DRYER WATER	<10hp	CS	-----	\$15,000
GA-812, DRYER REFLUX	<10hp	CS	-----	\$15,000
GA-813, PHENOL COL REFLUX	20HP	CS	-----	\$20,000
GA-814, PHENOL DRAWOFF	<10hp	CS	-----	\$15,000
GA-815, PHENOL COL BTM	<10hp	CS	-----	\$15,000
GA-816, STRIPPING COL REFLUX	<10hp	CS	-----	\$15,000
GA-817, STRIPPING COL EXTRACT	<10hp	CS	-----	\$15,000
GA-818, STRIPPING COL BTM	<10hp	CS	-----	\$15,000
GA-819, PHENOL CHANGE	<10hp	CS	-----	\$15,000
GA-820, DRYER COL BTMS	<10hp	CS	-----	\$15,000
GA-821, WASH WATER	<10hp	CARP 20	-----	\$30,000
GA-822, TAR CIRC.	<10hp	CARP 20	-----	\$30,000
GA-823, WASH WATER CIRC	<10hp	CARP 20	-----	\$30,000
GA-824, TAR PUMP	<10hp	CS	-----	\$15,000
GA-825, TAR STORAGE	<10hp	CS	-----	\$15,000
GA-826, LT. ENDS COL WATER PUMP	<10hp	CS	-----	\$15,000
			TOTA	\$440,000

DOE JET FUEL

EQUIPMENT SUMMARY

FD-801 1ST STG WASH FILTER	\$5,000
FD-802 2ND STG WASH FILTER	\$5,000
GD-801 1ST STG WASH MIXER	\$5,000
GD-802 2ND STG WASH MIXER	\$5,000
GD-803 SULFURIC ACID MIXER	\$5,000
ED-801 THIN FILM EVAP	\$90,000
PA-801 VACUUM SYSTEM	<u>\$50,000</u>
TOTAL	\$165,000

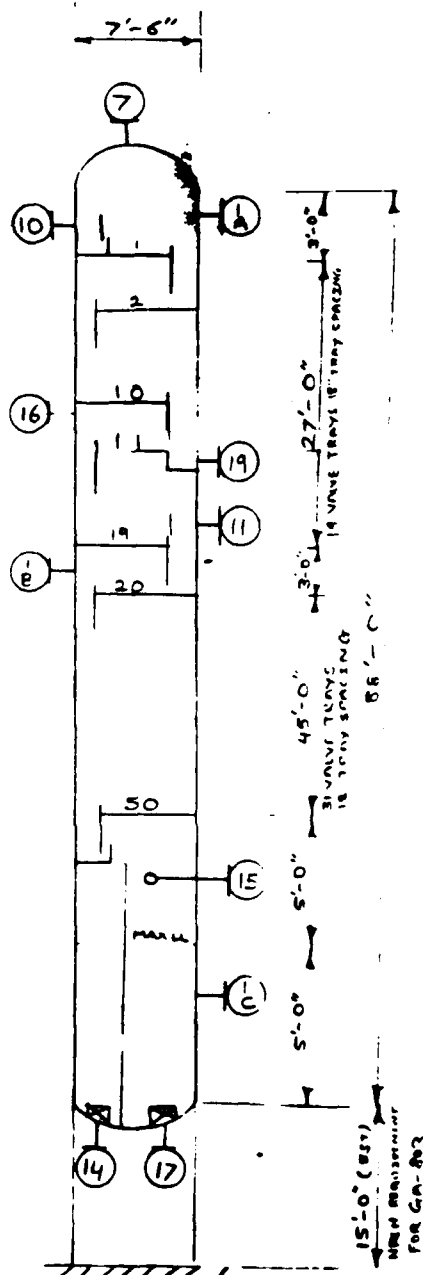
DOE JET FUEL

VESSEL NO. DA-801 COME WITH
 VESSEL NAME FLAG COLUMN
 DIAMETER 7'-6" R-4 8
 VERT HT 85'-0" R-4 8
 NOZZLE LENGTH
 OPER TEMP. TOP 194 ° BOT 445 ° DRUM
 MAX TEMP. TOP 194 ° BOT 445 ° DRUM
 NORM OPER PRESS 12.7 (12.2) PSIG OR 6 (6.0) PSIG
 MAX OPER PRESS _____ PSIG OR _____ PSIG
 CORROSION ALLOW. SHELL 4.5mm IN DRUM _____ IN
 DES TEMP 470 °
 DES PRESS 4.5 PSIG VAC FULL INCH
 HEADS: SUP ✓ DISCH ✓ CONE _____ FLAT _____
 CODE ASME VIII WP _____ OTHER _____
 STRESS RELIEVED: YES ✓ CODE _____
 RADIOGRAPHED: YES _____ CODE _____
 EARTHQUAKE: _____ WELD _____
 MATL: SHELL CS LINER NO. 12 THK _____
 INSULATION: CONSERV ✓ PROTECT NO MORE _____
 DECK MATL: CS VALVE MATL. 304 SS

NOZZLES: FLG CLASS 150 COUPL CLASS _____

ITEM NO.	NO.	SIZE	SERVICE & SYMBOL
1	2	24	MANHOLE
2			MANHOLE
3			
4			MANHOLE
5			
6	1	6	VAPOR OUTLET TO <u>EA-801</u>
7			VENT
8			TO VACUUM EQUIPMENT
9	1	2	REFLUX IN FROM <u>FA-801</u>
10			
11	1	2	FEED FROM <u>GA-801</u>
12			FEED FROM _____
13			FEED FROM _____
14	1	10	TO REBOILER (FEED PUMP)
15			FROM REBOILER
16	1	20	SQUALIZING LINE WITH <u>FA-807</u>
17	1	1/2	BOTTOM OUTLET TO <u>GA-803</u>
18			LIQUID OUTLET TO _____
19	1	2	DRAWOFF TO <u>FA-807</u>
20			RETURN FROM _____
21			DRAWOFF TO _____
22			RETURN FROM _____
23			DRAWOFF TO _____
24			RETURN FROM _____
25			REFLUX DRAFFOFF TO _____
26			REFLUX IN FROM _____
27			REFLUX DRAFFOFF TO _____
28			REFLUX IN FROM _____
29			PROCESS STEAM
30			STEAM OUT (SO)
31			DRAIN
32			SAMPLE DOWN (SL COOLER (SO)
33			SAFETY VALVE (SV)
34			SAFETY VALVE (SV) (SV)
35			UTILITY CONNECTION
36			PRESSURE GAUGE (PG)
37			PRESSURE CONTROLLER P _____
38			PRESSURE TAP (PT)
39			
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (TC) _____
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

PLANNED NOZZLES ARE
 CLASSIFIED LMS
 FOR COUPLING ADD
 80 TO NOZZLE NO.



NOTES:
 (1) LQMSD "P.G.R. = 97 (avg) @ operating temp
 (2) BIEL SS CLAD BELOW TRAY 22.
 NO CORROSION ALLOW FOR CS SHELL IN
 THIS SECTION

NAME		FOR TRAY 4		GA																					
REV		DATE		DESCRIPTION		PROJ: DESIGN		PROJ: ASSEMBLY		APPR: APPROVED		APPR: APPROVED		VESSEL NO DA 801		DESIGNER									

		THE LAMAR COMPANY	
TITLE: JET FUEL PROJECT			
CLIENT: AMARCO PET - COMBUSTION DIVISION, NORTH DAKOTA			
PROJECT: FLAGSHIP PROJECT			
PROJECT NO: 71			
PROJECT: VESSEL DESIGN			
VESSEL NO: DA 801			
DESIGNER:			

DATE	DESCRIPTION	AMOUNT	BALANCE
1994-01-01	OPENING BALANCE	100.00	100.00
1994-01-15	PAYROLL	50.00	50.00
1994-01-31	RENT	25.00	25.00
1994-02-15	UTILITIES	10.00	15.00
1994-02-28	SALES	75.00	90.00
1994-03-15	PAYROLL	50.00	40.00
1994-03-31	RENT	25.00	15.00
1994-04-15	UTILITIES	10.00	5.00
1994-04-30	CLOSING BALANCE	5.00	5.00

LAURENCE H. HARRIS

TRAVEL EXPENSES
 1960-1961
 1962-1963
 1964-1965
 1966-1967
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 2542-25

DESIGN CODE	WATER RATE L/min	WATER QUALITY TDS/PPM	TEMPERATURE °C	SURFACE TENSION DYNES/CM	LIQUID VISCOSITY CENTIPOISE
1	10	100	20	72	100
2	10	100	20	72	100
3	10	100	20	72	100
4	10	100	20	72	100
5	10	100	20	72	100
6	10	100	20	72	100
7	10	100	20	72	100
8	10	100	20	72	100
9	10	100	20	72	100
10	10	100	20	72	100
11	10	100	20	72	100
12	10	100	20	72	100
13	10	100	20	72	100
14	10	100	20	72	100
15	10	100	20	72	100
16	10	100	20	72	100
17	10	100	20	72	100
18	10	100	20	72	100
19	10	100	20	72	100
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21	10	100	20	72	100
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23	10	100	20	72	100
24	10	100	20	72	100
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28	10	100	20	72	100
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30	10	100	20	72	100
31	10	100	20	72	100
32	10	100	20	72	100
33	10	100	20	72	100
34	10	100	20	72	100
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36	10	100	20	72	100
37	10	100	20	72	100
38	10	100	20	72	100
39	10	100	20	72	100
40	10	100	20	72	100
41	10	100	20	72	100
42	10	100	20	72	100
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61	10	100	20	72	100
62	10	100	20	72	100
63	10	100	20	72	100
64	10	100	20	72	100
65	10	100	20	72	100
66	10	100	20	72	100
67	10	100	20	72	100
68	10	100	20	72	100
69	10	100	20	72	100
70	10	100	20	72	100

[illegible]

MINIMUM :	61195.75	-0982	42825.00	\$7,930.00	51.54	.40200
(CALCULON TURN) ON TO	10.00	W/16 VARS	ACCT 15	70.00	VARIABLE RATES FOR	4141904 LOADED TRAY)

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U.S. DEPT. OF JUSTICE

UJAL-1402-1001

STATISTICS

שנה	מספר	שם
2011	1	אברהם
2012	2	בנימין
2013	3	גדליהו
2014	4	הושע
2015	5	יהושפט
2016	6	יוסף
2017	7	מנחם
2018	8	נחמיה
2019	9	עזריאל
2020	10	פנחס
2021	11	רפאל
2022	12	שמעון
2023	13	שלמה
2024	14	יחזקאל
2025	15	יהונתן
2026	16	יוחנן
2027	17	משה
2028	18	נח
2029	19	דוד
2030	20	שלום

[illegible]

THE UNIVERSITY OF CHICAGO

[illegible]

U) 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1

U.S. DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF INVESTIGATION
WASHINGTON, D. C. 20535

U.S. DEPARTMENT OF AGRICULTURE

[illegible]

ATTENTION: ALL INFORMATION FOR THIS TRAY

VESSEL NO. DA-802 COME WITH _____
 VESSEL NAME DRYER COLUMN
 DIAMETER 4'-0" R-4
 VERT HT 25'-3" R-4 SHORT 15'-0" R-4
 HORIZ LENGTH _____ R-4
 OPER TEMP: TOP 221 ° BOT 250 ° DRUM _____ °
 MAX TEMP: TOP _____ ° BOT _____ ° DRUM _____ °
 NORM OPER PRESS -12.5/12.5 PSIG OR -12.7/12.7 PSIG
 MAX OPER PRESS _____ PSIG OR _____ PSIG
 CORROSION ALLOW: SHELL 4.5 IN @ DECK _____ IN

DES TEMP 300 °
 DES PRESS 4.5 PSIG MAX VAC FULL IN HG
 HEAD: SLIP _____ DISHED _____ CONE _____ FLAT _____
 CODE: ASME VI AP _____ OTHER _____
 STRESS RELIEVED: YES ☒ CODE _____
 RADIOGRAPHED: YES _____ CODE _____
 EARTHQUAKE: YES _____ WIND _____ PSF

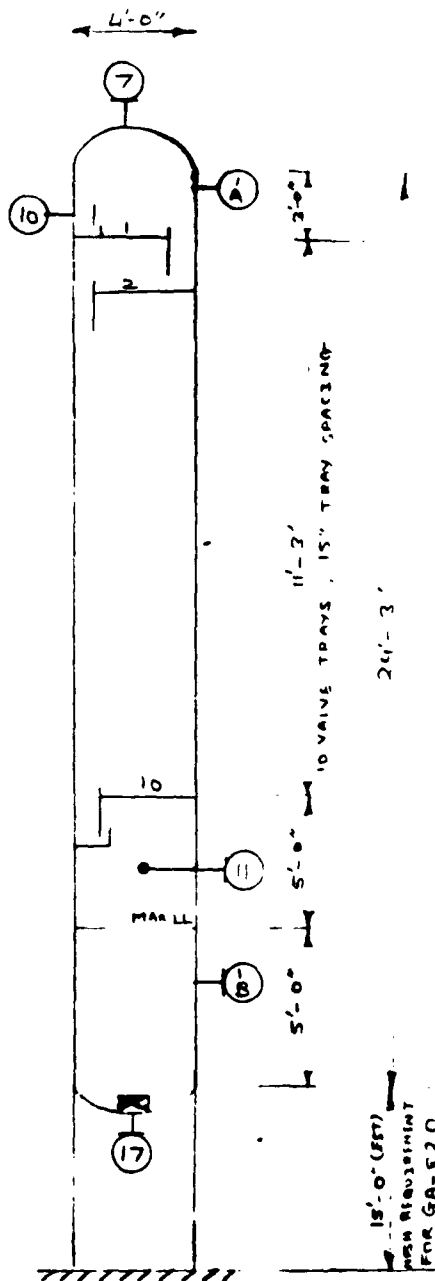
MATL: SHELL CS LINER NOTE (b) TIR IN
 INSULATION: CONSERVATION ☒ PROTECTIN _____ NONE _____
 DECK MATL: CS VALVE MATL: 2414S

NOZZLES: FLG CLASS 150 COUPL CLASS _____

ITEM NO.	NO.	SIZE	SERVICE & SYMBOL
1	<u>2</u>	<u>24</u>	MANHOLE
2			MANHOLE
3			
4			
5			MANHOLE
6			
7	<u>10</u>		VAPOR OUTLET TO <u>EA-105</u>
8			VENT
9			TO VACUUM EQUIPMENT
10	<u>1 1/2</u>		REFILL IN FROM <u>EA-802</u>
11	<u>1 1/2</u>		FEED FROM <u>EA-802</u>
12			FEED FROM _____
13			FEED FROM _____
14			TO REBOILER (REF. PUMP)
15			FROM REBOILER
16			SQUALLERS LINE WITH _____
17	<u>2</u>		BOTTOM OUTLET TO <u>GA-820</u>
18			LIQUID OUTLET TO _____
19			DRAWOFF TO _____
20			RETURN FROM _____
21			DRAWOFF TO _____
22			RETURN FROM _____
23			DRAWOFF TO _____
24			RETURN FROM _____
25			REFILL DRAWOFF TO _____
26			REFILL IN FROM _____
27			REFILL DRAWOFF TO _____
28			REFILL IN FROM _____
29			PROCESS STEAM
30			STEAM OUT (SC)
31			DRUM
32			SAMPLE CONN. (R. COOLER (SC)
33			SAFETY VALVE (SV)
34			SAFETY VALVE (SV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAUGE (PG)
37			PRESSURE CONTROLLER (P) _____
38			PRESSURE TAP (PT)
39			
40			TEMPERATURE INDICATOR (TI) _____
41			TEMPERATURE CONTROLLER (TC) _____
42			TEMPERATURE RECORDER (TR) _____
43			TEMPERATURE WELL (TW) _____
44			
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL _____
47			INTERNAL LEVEL _____
48			LEVEL ALARM (LA) _____
49			

NOTES:

- 1) LIQUID SP. GR. = 0.78 (avg) @ operating temp.
- 2) 316L SS CLAD BELOW TRAY # 10. NO COR. ALLOW. FOR CS SHELL IN THIS SECTION.



		THE LUMBER COMPANY Houston	
WITH JET FUEL PROJECT SUSTAINABLE/DESIGN/CONSTRUCTION (SOLAR, NORTH, SOUTH, EAST, WEST) PROJECT (NOV 05/07)			
PROJECT VESSEL SYSTEM			
VESSEL NO. <u>DA-802</u>		PROJECT - <u>4</u>	

REV	DATE	DESCRIPTION	APP'D	CHK'D	DATE
1		FOR TRAY 4			

CE LUMIN, VALV TRAY COMPUTER PROGRAM 6-9217 RELEASED 03 DATED APR 25 1966 BATCH
 BY SUNIL JSTU AT 09:44:43 ON 04/11/79. DESIGN FINE ROUND 1 TO 500 LUMINUS JOB OR ESTIMATE 5571
 DA-802 DRYING COLUMN (ANG JET FUELS PROJECT) SHEET 302 OFFICE LTD

LAYOUT DIMENSIONS

TRAY SPACING-INCHES 15.000 INSIDE LOWER DIAMETER-INCHES 32.00 (502)
 TYPE OF FLOW SAF (1-PASS)

DESIGN ROOMS	VAPOR RATE LBS/HR	VAPOR DENSITY LBS/FT ³	LIQUID RATE LBS/HR	LIQUID DENSITY LBS/FT ³	SURFACE TENSION DYNES/CM	LIQUID VISCOSITY CENTIPOISE
MAXIMUM =	6568.00	.18140	7773.00	58.94000	20.96	.28300
(BASED ON OVERDESIGN TO 100.0 D/O OF VAPOR AND TO 100.0 D/O OF LIQUID MINIMAL RATES FOR MAXIMUM LOADED TRAY)						
MINIMUM =	2700.20	.13700	2497.80	58.13000	23.40	.29000
(BASED ON MINIMUM TO 100.0 D/O OF VAPOR AND TO 100.0 D/O OF LIQUID MINIMAL RATES FOR MINIMUM LOADED TRAY)						

DOWNCOMER LOCATION 1-SIDE
 DOWNCOMER TYPE 1- STRAIGHT

OUTLET NEAR ABOUT, INCHES 11 4.000
 DISTANCE INCHES 2.250 4.000
 DISTANCE INCHES 1.500 2.250
 DISTANCE INCHES 20.395 1.500
 DISTANCE INCHES 20.395 20.395

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NOTE 1 - PER DOWNCOMER, NOTE 2 - PER DOWNCOMER PLATE, NOTE 3 - DIMENSION ABOVE TRAY FLOR, NOTE 4 - HORIZONTAL DISTANCE
 NOTE 5 - DIMENSION INCHES REFER TO THE APPLICABLE MESSAGES ON THE DIAGNOSTICS SHEET, NOTE 6 - 0 INDICATES SPECIAL TRAY FEATURE
 NOTE 7 - 0 INDICATES SPECIAL TRAY FEATURE
 NOTE 8 - 0 INDICATES SPECIAL TRAY FEATURE
 NOTE 9 - 0 INDICATES SPECIAL TRAY FEATURE
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 NOTE 100 - 0 INDICATES SPECIAL TRAY FEATURE

VESSEL NO. DA 803 COME WITH
 VESSEL NAME PHENOL COLUMN
 DIAMETER 9'-0" S&S 15'-0"
 VENT HT. 11'-0" S&S 15'-0"
 NOZZLE LENGTH
 OPER TEMP TOP 212 ° BOTM 138 ° BRIM
 MAX TEMP TOP 212 ° BOTM 138 ° BRIM
 NORM OPER PRESS -13.7 (100) PSIG OR -5.0 (800) PSIG
 MAX OPER PRESS PSIG OR PSIG
 CORROSION ALLOW. SHELL 4.5 mm @ SEAMS

DES TEMP 375 °
 DES PRESS 45 PSIG VAC FULL
 HEADS: SLP X DISHED CONC CONE FLAT
 CODE ASME VIII API OTHER
 STRESS RELIEVED YES X CODE
 RADIOGRAPHED YES CODE
 EARTHQUAKE: WIND

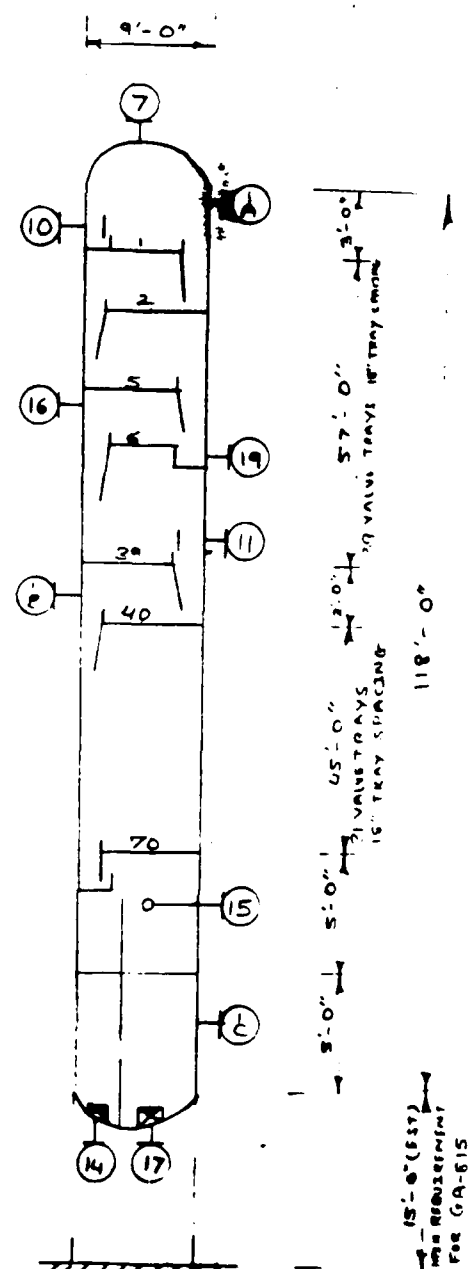
MATL: CS LINER N 316/2 THK
 INSULATION: CONSERV PROTECT NONE
 COOR MATL: CS VALVE DATA 204.65

NOZZLES FLG CLASS 150 COUPL CLASS

ITEM NO.	NO.	SIZE	SERVICE & SYMBOL
1	2	24	MANHOLE
2			MANHOLE
3			
4			MANHOLE
5			
6			
7	1	24	VAPOR OUTLET TO
8			VENT
9			TO VACUUM EQUIPMENT
10		4	REFLUX IN FROM <u>EA-803</u>
11	1	1/2	FEED FROM <u>GA-820</u>
12			FEED FROM
13			FEED FROM
14		1/2	TO RECOVER (FEED PUMP)
15		2	FROM RECOVER
16	1	2	EQUALIZING LINE WITH <u>EA-806</u>
17	1	1/2	BOTTOM-OUTLET TO <u>GA-815</u>
18			LIQUID-OUTLET TO
19	1	2	DRAWOFF TO <u>EA-808</u>
20			RETURN FROM
21			DRAWOFF TO
22			RETURN FROM
23			DRAWOFF TO
24			RETURN FROM
25			REFLUX DRAWOFF TO
26			REFLUX IN FROM
27			REFLUX DRAWOFF TO
28			REFLUX IN FROM
29			PROCESS STEAM
30			STEAM OUT (BO)
31			BRIM
32			SAMPLE DOWN (S) COOLER (CO)
33			SAFETY VALVE (SV)
34			SAFETY VALVE (SV) (HV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PG)
37			PRESSURE CONTROLLER (P) <u>D</u>
38			PRESSURE TAP (PT)
39			
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (TC) <u>D</u>
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE
 SUPPLIED 150
 FOR COUPLING AND
 80 TO NOZZLE NO.

EA-807



- LIQUID SP. GR. = 0.942 (avg) @ operating temp.
 - 216L CS CLAD BELOW TRAY # 5.
- NO CORR ALLOW. FOR CS SHELL IN THIS SECTION.

		THE LUMMUS COMPANY Houston	
WELD JET FUEL PROTECT SLANT PRICE/1000 LBS. COMPRESSION 1/2" DIA. GAGE. 1/2" DIA. 05571			
FURNISH VESSEL SECTION			
VESSEL NO. <u>DA-803</u>		DESIGN	

VESSEL NO. DA-805 DESIGNED WITH
 VESSEL NAME LYGHT ENDS COLUMN
 DIAMETER 3'-8" R-4 &
 VERT HT. 31'-0" R-4 SHORT 15'-0" R-4
 HORIZ LENGTH
 OPER TEMP TOP 222 ° BOT 372 ° DRUM
 MAX TEMP TOP ° BOT ° DRUM °
 NORM OPER PRESS 0.8 (TOP) PSIG OR 4.2 (BOT) PSIG
 MAX OPER PRESS PSIG OR
 CORROSION ALLOW: SHELL 4.5 mm & DRUM

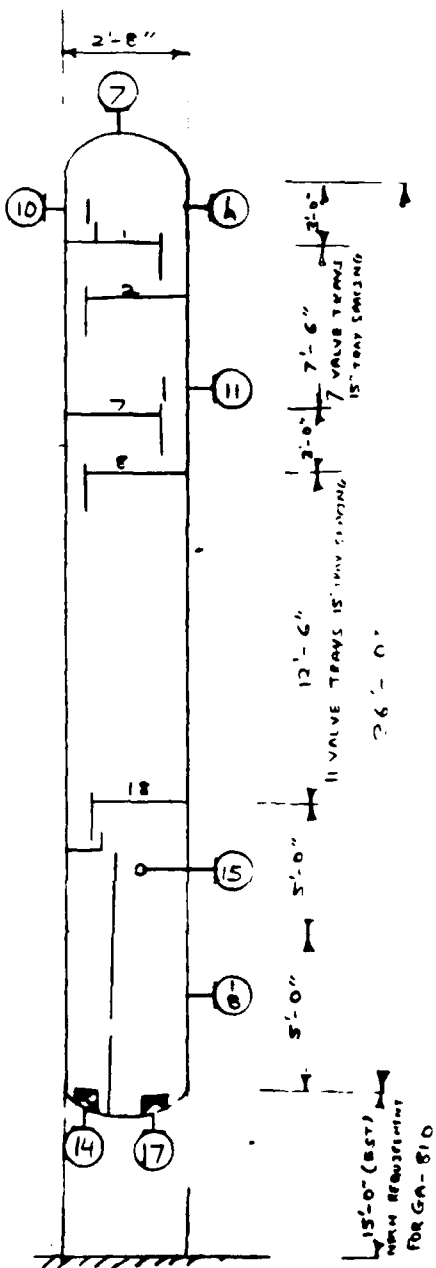
DES TEMP 400 °
 DES PRESS 4.5 PSIG VAC
 HEADS: SLIP PREPARED COORE PLAT
 CODE ASME VI API OTHER
 STRESS RELIEVED: YES Y CODE
 RADIOGRAPHED: YES CODE
 EARTHQUAKE: WIND

MATL: SHELL CS LINER NOTED TIR
 INSULATION: CONSERVYN Y PROTECTN REFR
 DECK MATL: CS VALVE NATL 2041SS

NOZZLE: FLG CLASS 150 COUP CLASS

ITEM NO.	NO.	SIZE	SERVICE & SYMBOL
1	24		MANHOLE
2			MANHOLE
3			
4			MANHOLE
5			
6			
7			VAPOUR OUTLET TO VENT
8			TO VACUUM EQUIPMENT
9			REFLEX IN FROM <u>EA-805</u>
10			FEED FROM <u>GA-805</u>
11			FEED FROM
12			FEED FROM
13			TO REBOILER (FEED PUMP)
14			FROM REBOILER <u>EA-809</u>
15			EQUALIZING LINE WITH
16			BOTTOM OUTLET TO <u>GA-810</u>
17			LIQUID OUTLET TO
18			DRAWOFF TO
19			RETURN FROM
20			DRAWOFF TO
21			RETURN FROM
22			DRAWOFF TO
23			RETURN FROM
24			REFLEX DRAWOFF TO
25			REFLEX IN FROM
26			REFLEX DRAWOFF TO
27			REFLEX IN FROM
28			PROCESS STEAM
29			STEAM OUT (CO)
30			DRUM
31			SAMPLE DOWN IN COOLER (CO)
32			SAFETY VALVE (PSV)
33			SAFETY VALVE (PSV) (NEW)
34			UTILITY CONNECTION
35			PRESSURE GAUGE (PG)
36			PRESSURE CONTROLLER (PC)
37			PRESSURE TAP (PT)
38			
39			TEMPERATURE INDICATOR (TI)
40			TEMPERATURE CONTROLLER (TC)
41			TEMPERATURE RECORDER (TR)
42			TEMPERATURE WELL (TW)
43			
44			GASER GAUGE (G)
45			EXTERNAL LEVEL
46			INTERNAL LEVEL
47			LEVEL ALARM (LA)
48			
49			

PLANNED NOZZLES ARE
 REDESIGNED FOR
 FOR COUPLING ADD
 IN TO NOZZLE NO.



- NOTES:
 (1) LIQUID SP GR=0.92 (AVG) @ operating temp.
 (2) 216L SS CLAD BELOW TRAY 8 & 9. NO.
 CORN ALLOW FOR CS SHELL IN THIS SECTION

		THE LINDE COMPANY Houston	
WIND JET FUEL PROJECT CLIENT AND NO.: <u>GOVERNMENT/GOVERNMENT/GOVERNMENT</u> PROJECT NO. <u>2000 000000</u>			
PRESSURE VESSEL SECTION			
REV	DATE	DESCRIPTION	VESSEL NO. <u>DA-805</u> SHEET NO. <u>1</u>

CE LUMNUS
BY SUMEL

VALVE TRAY COMPUTER PROGRAM 4-7217
JSED AT 09:19:43 ON 04/11/79.
LANG JET FUELS PROJECT

RELEASED ON DATED APR 25 1986
DIVISION - FMD (MILITARY) IN SKF

BATCH
LUMNUS JDR DR ESTIMATE 5571
DEPT 302 OFFICE LTD

A-805

LAYOUT DIMENSIONS

TRAY SPACING, INCHES
TYPE OF FLOW

15.000
SKF (1-PASS)

INSIDY TOWER DIAMETER, INCHES

48.00

VAPOR RATE
LBS/M

VAPOR DENSITY
LBS/FT³

LIQUID RATE
LBS/HR

LIQUID DENSITY
LBS/FT³

SURFACE TENSION
DYNES/CM

LIQUID VISCOSITY
CENTIPOISE

MAXIMUM =

0.01640

7902.00

61.42000

29.10

40800

BASED ON OVERDESIGN TO 100.0 O/D OF VAPOR AND TO 100.0 O/D OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY

MINIMUM =

0.01640

5641.40

61.42000

29.10

40800

BASED ON OVERDESIGN TO 100.0 O/D OF VAPOR AND TO 100.0 O/D OF LIQUID NOMINAL RATES FOR MINIMUM LOADED TRAY

DOWNCOMER LOCATED
DOWNCOMER TYPE

1-SID
1- STRAIGHT

(NOTE 2)

5.000

(NOTE 3)

5.000

(NOTE 4)

2.500

(NOTE 5)

29.326

(NOTE 6)

29.326

(NOTE 7)

5.000

(NOTE 8)

5.000

(NOTE 9)

5.000

(NOTE 10)

29.326

NOTE 1 - PER DOWNCOMER PLATE NOTE 2 - PER DOWNCOMER PLATE NOTE 3 - DIMENSION ABOVE TRAY FLOOR, NOTE 4 - HORIZONTAL DISTANCE

NOTE 5 - SPECIAL TRAY FEATURE

NOTE 6 - VALVE TRAY DATA SHEET TO MAKE A PROCESS SPECIFICATION FOR THIS TRAY

1

ITEM NUMBER	SERVICE	MATERIAL	HEAT EXCHANGER MEDIUM					TEMPERATURE OF		DUTY TEMP RANGE	OVERALL HEAT TRANS COEFF. BY AREA	FOUL FACTOR	TOTAL SURFACE	MAX ALLOWABLE PRESS DROP IN	PRESS. DUG		SIZE AND TYPE		MATERIALS		
			FLOW RATE	SPECIFIC GRAVITY	MOLECULAR WEIGHT	VISCOSITY AT AVO TEMP	% VAPORIZED BY WEIGHT	% CONDENSED BY WEIGHT	IN						OUT	OPERATING	DESIGN	NO UNITS AND OD BY LENGTH	TYPE TEMA SYMBOLS	SHELL	TUBES
EA-801	FLAM COL CONDENSER	TEMP WATER	44000	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	10	CS	TUBES
EA-802	FLAM COL CONDENSER	TEMP WATER	71115	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-803	FLAM COL CONDENSER	TEMP WATER	33500	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-804	FLAM COL CONDENSER	TEMP WATER	52000	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-805	FLAM COL CONDENSER	TEMP WATER	30000	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-806	FLAM COL CONDENSER	TEMP WATER	25000	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-807	FLAM COL CONDENSER	TEMP WATER	72235	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-808	FLAM COL CONDENSER	TEMP WATER	78000	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-809	FLAM COL CONDENSER	TEMP WATER	20760	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-810	FLAM COL CONDENSER	TEMP WATER	493000	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-811	FLAM COL CONDENSER	TEMP WATER	83000	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-812	FLAM COL CONDENSER	TEMP WATER	103280	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-813	FLAM COL CONDENSER	TEMP WATER	54000	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-814	FLAM COL CONDENSER	TEMP WATER	72280	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-815	FLAM COL CONDENSER	TEMP WATER	17500	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-816	FLAM COL CONDENSER	TEMP WATER	102000	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-817	FLAM COL CONDENSER	TEMP WATER	42500	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-818	FLAM COL CONDENSER	TEMP WATER	37780	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-819	FLAM COL CONDENSER	TEMP WATER	73500	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	
EA-820	FLAM COL CONDENSER	TEMP WATER	55555	1.0	18	0.01	0.0	100	100	125	0.0	1195	10	10	10	10	10	10	CS	TUBES	

VESSEL NO FA-801 COME WITH
 VESSEL NAME FLASK COLUMN REFLEX DRUM
 DIAMETER 3'-0" R-40 & R-40
 VERT HT 9'-0" R-40 SHORT
 HORIZ LENGTH 9'-0" R-40
 OPER TEMP TOP 190 ° F BOT 190 ° F
 MAX TEMP TOP 190 ° F BOT 190 ° F
 NORM OPER PRESS 150 PSIG OR 150 PSIG
 MAX OPER PRESS 150 PSIG OR 150 PSIG
 CORROSION ALLOW 1/8" SHELL & DECKS

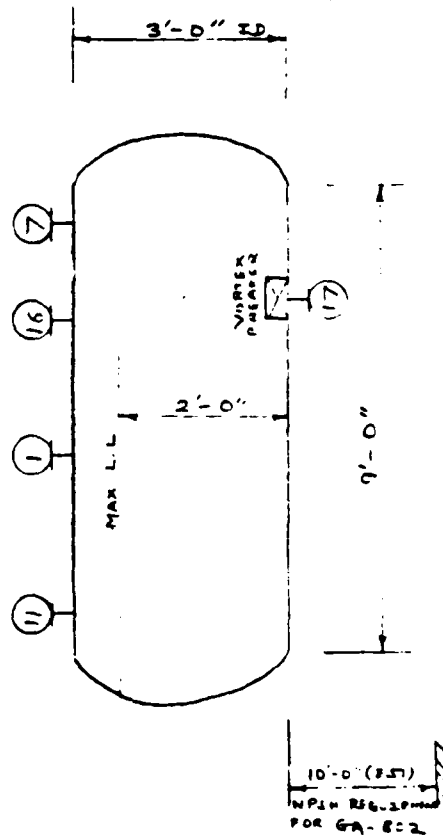
DES TEMP 220 ° F
 DES PRESS 150 PSIG VAC FULL PSIG
 HEADS ELIP DISHED ✓ CONE FLAT
 CODE ASME VIII AP OTHER
 STRESS RELIEVED YES ✓ CODE
 RADIOGRAPHED YES ✓ CODE
 EARTHQUAKE WIND R-40

MATL: SHELL CS LINER THK
 INSULATION CONSERV ✓ PROTECT NONE
 DECK MATL

NOZZLES FLG CLASS 150 COUPL CLASS

ITEM NO	SIZE	SERVICE & SYMBOL
1	1/2"	MANHOLE
2	1/2"	MANHOLE
3		
4		
5		MANHOLE
6	6"	VAPOR OUTLET TO <u>EA-804</u>
7		VENT
8		TO VACUUM EQUIPMENT
9		REFLUX IN FROM
10	4"	FEED FROM <u>EA-801</u>
11		FEED FROM
12		FEED FROM
13		FEED FROM
14		TO REBOILER (RES PUMP)
15		FROM REBOILER
16	1/2"	EQUALIZING LINE WITH <u>EA-801</u>
17	4"	BOTTOM OUTLET TO <u>GA-802</u>
18		LIQUID OUTLET TO
19		DRAFF TO
20		RETURN FROM
21		DRAFF TO
22		RETURN FROM
23		DRAFF TO
24		RETURN FROM
25		REFLUX DRAFF TO
26		REFLUX IN FROM
27		REFLUX DRAFF TO
28		REFLUX IN FROM
29		PROCESS STEAM
30		STEAM OUT (BO)
31		DRAIN
32		SAMPLE CONN (S) COOLER (CO)
33		SAFETY VALVE (PSV)
34		SAFETY VALVE (PSV) (MSV)
35		UTILITY CONNECTION
36		PRESSURE GAUGE (PG)
37		PRESSURE CONTROLLER (P) <u>Q</u>
38		PRESSURE TAP (PT)
39		
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (TC) <u>Q</u>
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44		
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49		
50		

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO

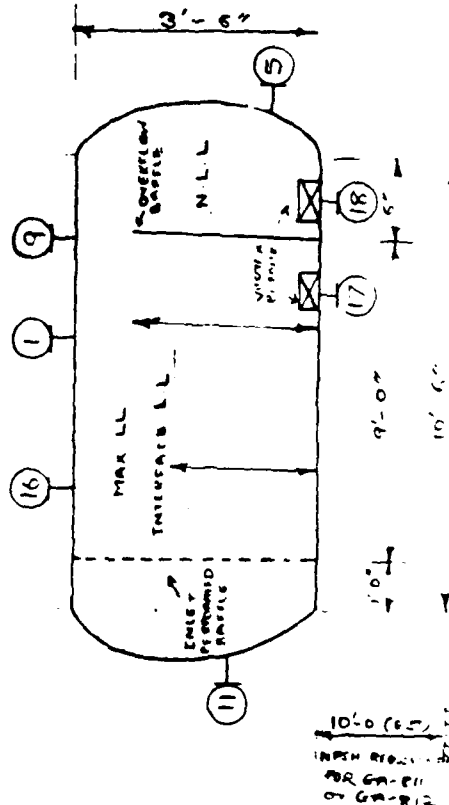


150 SP GR = 101 @ opening temp

		THE LUMMUS COMPANY	
		Engineers	
TITLE <u>JET FUEL PROJECT</u> CLIENT <u>ARMED & DANGEROUS</u> LOCATION <u>BEULAH, MISSISSIPPI</u> PROJ NO <u>05571</u>			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	DESIGN
1	1/1/51	FOR TRK 4	
VESSEL NO <u>FA-801</u>		SHEET NO <u>1</u>	

WHEELER: PLO CLASS 150 COUPL CLASS 1

FLAMING NOZZLES ARE
DESIGNED FOR
FOR CLEANING AND
AS TO NOZZLE NO.



LIQUID SP. GR. 1.015 (avg) @ operating temp.

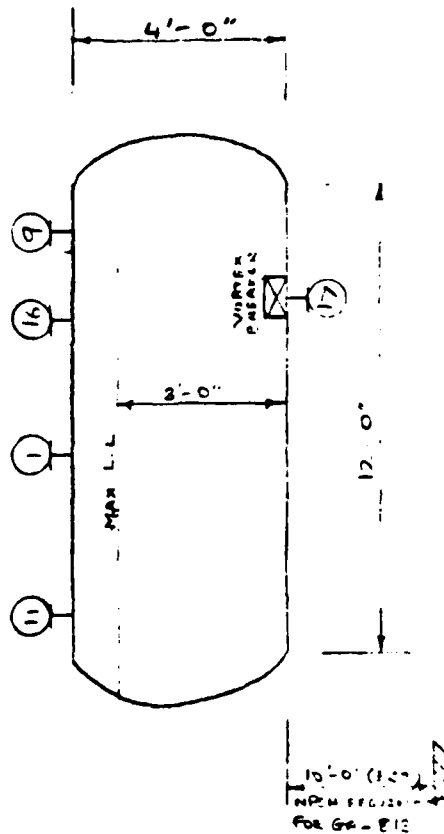
[illegible]

VESSEL NO. FA-803 COME WITH
 VESSEL NAME PHENOL COL REFILLER DEUM
 DIAMETER 4'-0" R-0 S
 VENT HT 12'-0" R-0 SHORT
 NO VZ LENGTH 12'-0" R-0
 OPER TEMP TOP 4 BOTY 4 BRUM 4
 MAX TEMP TOP 4 BOTY 4 BRUM 4
 NORM OPER PRESS 100 OR 100
 MAX OPER PRESS 100 OR 100
 CORROSION ALLOW. SHELL 5 S-0 S-0
 DES TEMP 240
 DES PRESS 45 VAC FULL
 HEADS: SLIP 1 R-0 S-0 PLAT
 CODE: ASME 1 API 1 OTHER
 STRESS RELIEVED YES 1 CODE
 RADIOGRAPHED YES 1 CODE
 EARTHQUAKE YES 1 CODE
 MATL: SHELL C-5 LINER 1 TMR
 INSULATION CONSERVYN 1 PROTECTN 1 NONE
 DECK MATL

NOZZLES: PLS CLASS 150 COUPL CLASS

ITEM NO.	NO.	SIZE	SERVICE & SYMBOL
1	1	12	MANHOLE
2	2	12	MANHOLE
3	3	12	MANHOLE
4	4	12	MANHOLE
5	5	12	MANHOLE
6	6	12	MANHOLE
7	7	12	MANHOLE
8	8	12	MANHOLE
9	9	12	MANHOLE
10	10	12	MANHOLE
11	11	12	MANHOLE
12	12	12	MANHOLE
13	13	12	MANHOLE
14	14	12	MANHOLE
15	15	12	MANHOLE
16	16	12	MANHOLE
17	17	12	MANHOLE
18	18	12	MANHOLE
19	19	12	MANHOLE
20	20	12	MANHOLE
21	21	12	MANHOLE
22	22	12	MANHOLE
23	23	12	MANHOLE
24	24	12	MANHOLE
25	25	12	MANHOLE
26	26	12	MANHOLE
27	27	12	MANHOLE
28	28	12	MANHOLE
29	29	12	MANHOLE
30	30	12	MANHOLE
31	31	12	MANHOLE
32	32	12	MANHOLE
33	33	12	MANHOLE
34	34	12	MANHOLE
35	35	12	MANHOLE
36	36	12	MANHOLE
37	37	12	MANHOLE
38	38	12	MANHOLE
39	39	12	MANHOLE
40	40	12	MANHOLE
41	41	12	MANHOLE
42	42	12	MANHOLE
43	43	12	MANHOLE
44	44	12	MANHOLE
45	45	12	MANHOLE
46	46	12	MANHOLE
47	47	12	MANHOLE
48	48	12	MANHOLE
49	49	12	MANHOLE
50	50	12	MANHOLE

PLANNED NOZZLES ARE
 SHOWN 1-00
 FOR COUPLING ADD
 80 TO NOZZLE NO.



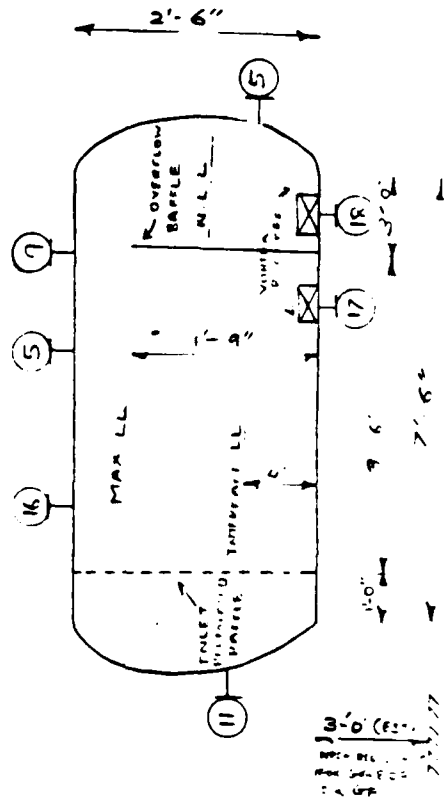
LIQUID SG GR = 0.91 @ operating temp

				THE LUMMAUS COMPANY Houston			
TITLE JET FUEL PROJECT CLIENT PHOENIX/ONE - BEAT LOCATION BULAW, NORTH PLANTING BRICK POINT SATOYA PROJ NO 08871							
PROCESS VESSEL SKETCH							
REV	DATE	DESCRIPTION	DESIGN	PROCESS	APPROV	APPROV	VESSEL NO FA-803

VESSEL NO FA 805 COME WITH
 VESSEL NAME LIGHT ENDS COLUMN REFLUX DRUM
 DIAMETER 2'-6" HGT 8'-0"
 VERT HT 8'-0"
 HORZ LENGTH 7'-6"
 OPER TEMP: TOP 150 BOT 150 DRUM 150
 MAX TEMP: TOP 150 BOT 150 DRUM 150
 NORM OPER PRESS 14.5 PSIG OR 14.5 PSIA
 MAX OPER PRESS 14.5 PSIG OR 14.5 PSIA
 CORROSION ALLOW: SHELL 4.5 mm S. BEAMS 4.5 mm
 DES TEMP 150
 DES PRESS 14.5 PSIG VAO FULL
 HEADS: SLIP ✓ DISPED ✓ CONE ✓ FLAT ✓
 CODE: ASME III API ✓ OTHER ✓
 STRESS RELIEVED: YES ✓ CODE ✓
 RADIOGRAPHED: YES ✓ CODE ✓
 EARTHQUAKE: YES ✓ CODE ✓
 MATL: SHELL CS LINER ✓ THE ✓
 INSULATION: CONSERV ✓ PROTECT ✓ NONE ✓
 DECK MATL: ✓
 NOZZLES: FLG CLASS 150 COUPL CLASS ✓

ITEM NO	NO	REQD	SIZE	SERVICE & SYMBOL
1				MANHOLE
2				MANHOLE
3				
4				MANHOLE
5				
6				WAPOR OUTLET TO VENT
7				TO VACUUM EQUIPMENT
8				REFLUX IN FROM
9				FEED FROM <u>FA-802</u>
10				FEED FROM
11				FEED FROM
12				TO CONDENSER (FEED PUMP)
13				FROM REBOILER
14				SCALING LINE WITH <u>FA-802</u>
15				BOTTOM OUTLET TO <u>FA-802</u>
16				LIQUID OUTLET TO <u>FA-802</u>
17				SHUTOFF TO
18				RETURN FROM
19				SHUTOFF TO
20				RETURN FROM
21				SHUTOFF TO
22				RETURN FROM
23				SHUTOFF TO
24				RETURN FROM
25				REPLACEMENT SHUTOFF TO
26				REPLACEMENT IN FROM
27				REPLACEMENT SHUTOFF TO
28				REPLACEMENT IN FROM
29				PROCESS STEAM
30				STEAM OUT (SI)
31				DRAIN
32				SAMPLE CONN. OR COOLER OR
33				SAFETY VALVE (SV)
34				SAFETY VALVE (SV) NEW
35				UTILITY CONNECTION
36				PRESSURE GAGE (PG)
37				PRESSURE CONTROLLER (PC) <u>0</u>
38				PRESSURE TAP (PT)
39				
40				TEMPERATURE INDICATOR (TI)
41				TEMPERATURE CONTROLLER (TC) <u>0</u>
42				TEMPERATURE RECORDER (TR)
43				TEMPERATURE WELL (TW)
44				
45				GRADE CLASS (G)
46				INTERNAL LEVEL
47				EXTERNAL LEVEL
48				LEVEL ALARM (LA)
49				
50				

PLANNED NOZZLES ARE
 INDICATED 150.
 FOR COMPLIANCE ADD
 ID TO NOZZLE NO.

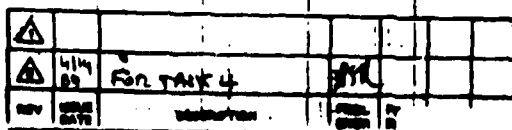


LIQID GP GR $\approx 0.92(\text{avg})$ E operating temp

		THE LUMBER COMPANY BOSTON	
WIL JET FUEL PROJECT CLIENT: AMCO/DOE CORPORATION, SEULAH, MISSISSIPPI PROJECT NO: 88571			
PROJECT VESSEL SHEET		1 FA-805	

		FOR VESSEL 4	SK
REV	DATE	DESCRIPTION	PREP

LIQUID SP GR = 1.02 @ operating temp



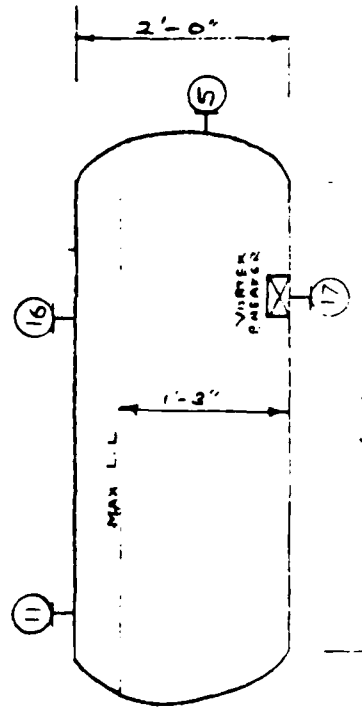
F-118

VESSEL NO. FA-807 CONN WITH _____
 VESSEL NAME CRYSTALL ACID DRUM
 DIAMETER 2'-0" HGT 5'-0"
 NO. 12 LENGTH 5'-0" HGT 5'-0"
 OPER. TEMP. TOP _____ BOT. _____
 MAX. TEMP. TOP _____ BOT. _____
 NORM. OPER. PRESS. _____ PSIG OR _____
 MAX. OPER. PRESS. _____ PSIG OR _____
 CORROSION ALLOW. SHELL 2" IN DECK _____
 DES. TEMP. 320 °F
 DES. PRESS. 4.5 PSIG VAC. FULL
 HEADS: ELP. WELD WELD WELD WELD WELD WELD
 CODE: ASME WELD WELD WELD WELD WELD WELD
 STRESS RELIEVED: YES WELD WELD WELD WELD WELD WELD
 RADIOGRAPHED: YES WELD WELD WELD WELD WELD WELD
 EARTHQUAKE: YES WELD WELD WELD WELD WELD WELD
 MATL. SHELL CS LINER _____ THK. _____
 INSULATION: CONSERVYN WELD PROTECTN. _____
 DECK MATL. _____

NOZZLES: FLG CLASS 150 COUPL. CLASS _____

ITEM NO.	NO.	SIZE	SERVICE & SYMBOL
1			MANHOLE
2			MANHOLE
3			MANHOLE
4			MANHOLE
5			MANHOLE
6			MANHOLE
7			VAPOR OUTLET TO
8			VENT
9			TO VACUUM EQUIPMENT
10			REFILL IN FROM
11			FEED FROM <u>FA-801/1-165</u>
12			FEED FROM
13			FEED FROM
14			TO REBOILER (RES. PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH <u>FA-801</u>
17			BOTTOM OUTLET TO <u>FA-801</u>
18			LIQUID OUTLET TO
19			DRAWOFF TO
20			RETURN FROM
21			DRAWOFF TO
22			RETURN FROM
23			DRAWOFF TO
24			RETURN FROM
25			REFILL DRAFF TO
26			REFILL IN FROM
27			REFILL DRAFF TO
28			REFILL IN FROM
29			PROCESS STREAM
30			STEAM OUT (SC)
31			BRAN
32			SAMPLE CONN. (S) COOLER (C)
33			SAFETY VALVE (SV)
34			SAFETY VALVE (SV) (MS)
35			UTILITY CONNECTION
36			PRESSURE GAUGE (PG)
37			PRESSURE CONTROLLER (P)
38			PRESSURE TAP (PT)
39			TEMPERATURE INDICATOR (TI)
40			TEMPERATURE CONTROLLER (T)
41			TEMPERATURE RECORDER (TR)
42			TEMPERATURE SENS. (TS)
43			GAUGE ON HED (GH)
44			EXTERNAL LEVEL
45			INTERNAL LEVEL
46			LEVEL ALARM (LA)

FLANGED NOZZLES ARE
MARKED 1-50
FOR COUPLING AND
IS TO NOZZLE HED.



10'-0" (EST.)
NEED REVISION
FOR GA-810

LIQUID SP. GR.: 0.94 @ operating temp.

		THE LUMMUS COMPANY Houston	
WILJET FUEL PROJECT CLIENT AND/OR: LUMMUS, NORTH DAKOTA PLANT SPEC. PLAN: 000005371			
PROCESS VESSEL SKETCH			
VESSEL NO. <u>FA-807</u>		SHEET NO. <u>000</u>	

REV	DATE	DESCRIPTION	BY	CHK	APP	APP
1	4/14/88	FOR TANK 4				

VESSEL NO. FA-808 COMP WITH
 VESSEL NAME PHINDI LPPM CFI 200M
 DIAMETER 2'-0" R-4 8
 VERT HT 4'-0" R-4 8
 HORIZ LENGTH 4'-0" R-4 8
 OPER TEMP: TOP 274 °F BOT 274 °F
 MAX TEMP: TOP 274 °F BOT 274 °F
 NORM OPER PRESS 3.5 PSIG OR 3.5 PSIA
 MAX OPER PRESS 3.5 PSIG OR 3.5 PSIA
 CORROSION ALLOW: SHELL IN DECOR IN

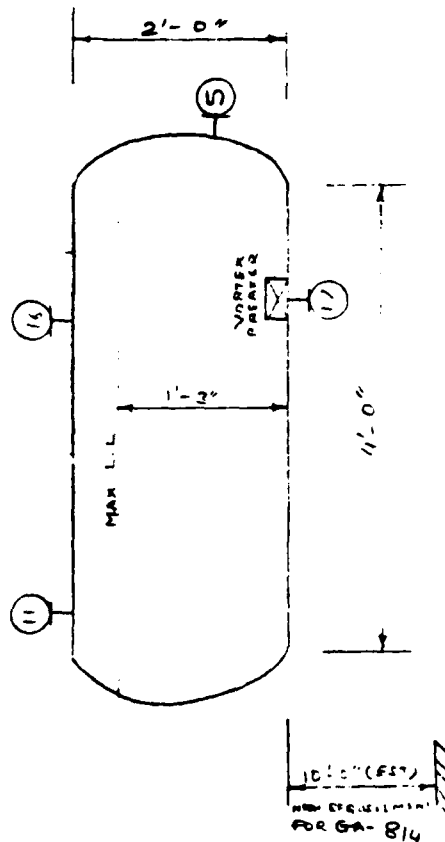
DES TEMP 274 °F
 DES PRESS 4.5 PSIG VAC FULL PSIG
 HEAD: ELIP DISHD ☒ DOME FLAT
 CODE: ABME VIII API OTHER
 STRESS RELIEVED YES ☒ CODE
 RADIOGRAPHED YES ☒ CODE
 EARTHQUAKE WIND RSH

MATL: SHELL CS LINER 316 SS CLASTIK IN
 INSULATION CONSERVYN ☒ PROTECT'N NONE
 DECK MATL

NOZZLES: FLO CLASS 150 COUP CLASS

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1			MANHOLE
2			MANHOLE
3			
4			
5			MANHOLE
6			
7			VAPOR OUTLET TO
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11			FEED FROM <u>FA-808 (CJIC 200M)</u>
12			FEED FROM
13			FEED FROM
14			TO REBOILER (REB PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH <u>DA-803</u>
17			BOTTOM OUTLET TO <u>GA-814</u>
18			LIQUID OUTLET TO
19			DRAFF TO
20			RETURN FROM
21			DRAFF TO
22			RETURN FROM
23			DRAFF TO
24			RETURN FROM
25			REFLUX DRAFF TO
26			REFLUX IN FROM
27			REFLUX DRAFF TO
28			REFLUX IN FROM
29			PROCESS STEAM
30			STEAM OUT (SO)
31			DRAIN
32			SAMPLE COHN (S) COOLER (CO)
33			SAFETY VALVE (SV)
34			SAFETY VALVE (SV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PG)
37			PRESSURE CONTROLLER (P) <u>Q</u>
38			PRESSURE TAP (PT)
39			
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T) <u>Q</u>
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

PLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO



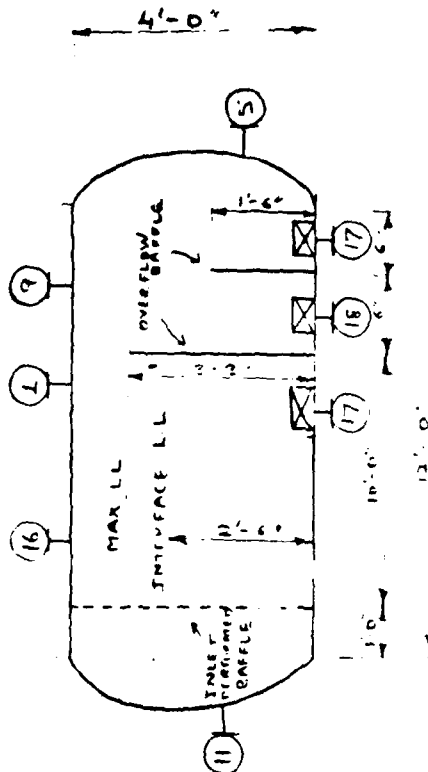
LIQ S: GR-097 @ operating temp

△									
△	414	For TAP 4							
REV	DATE	DESCRIPTION	PREP	CHKD	APPD	APPD	VESEL NO	FA-808	DRG DES -

CE LUMMUS		THE LUMMUS COMPANY Houston	
TITLE <u>JET FUEL PROJECT</u> CLIENT AND/OR OFF. ORIGIN LOCATION <u>BRULAH</u> PLANT <u>PLANT 1</u> JOB NO <u>05571</u>			
PROCESS VESSEL SKETCH			
VESSEL NO <u>FA-808</u>		DRG DES -	

NOZZLE FLG CLASS 150 COUPL CLASS 1

PLANNED NOZZLES ARE
IDENTIFIED 1-4.
FOR COMPLIES AND
IS TO NOZZLE NO.



10-0

LIQ. SP. GR = 0.99 (avg) @ operating temp.

[illegible]

VESSEL NO FB-F01 COME WITH _____
 VESSEL NAME SULFURIC ACID TANK (66" H₂SO₄)
 DIAMETER 66" IN & _____ IN
 VERT HT 8'-0" IN BURT _____ IN
 HORIZ LENGTH _____ IN
 OPER TEMP TOP _____ ° F BOTT _____ ° F DRUM AMT ° F
 MAX TEMP TOP _____ ° F BOTT _____ ° F DRUM _____ ° F
 NORM OPER PRESS _____ PSI OR _____ PSI
 MAX OPER PRESS _____ PSI OR _____ PSI
 CORROSION ALLOW SHELL 2.5 IN DECK _____ IN

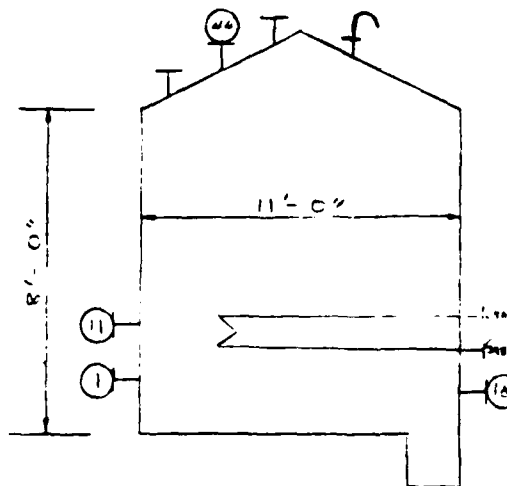
DES TEMP 220 ° F
 DES PRESS 2 H₂O PSI VAC -2 H₂O PSI
 HEADS SLIP _____ DISHED _____ CONE EDGE FLAT BOTTOM
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ PSI

MATL SHELL CS LINER _____ THK _____ IN
 INSULATION CONSERV'N _____ PROTECT'N _____ NONE
 DECK MATL _____

NOZZLES FLG CLASS 150 COUPL CLASS _____

ITEM NO	SIZE	SERVICE & SYMBOL
1	<u>24</u>	MANHOLE
2		MANHOLE
3		
4		
5		MANHOLE
6		
7		VAPOR OUTLET TO
8		VENT
9		TO VACUUM EQUIPMENT
10		REFLUX IN FROM
11	<u>3</u>	FEED FROM <u>TANK TRUCK</u>
12		FEED FROM
13		FEED FROM
14		FEED FROM
15		TO REBOILER (RES. PUMP)
16		FROM REBOILER
17		EQUALIZING LINE WITH
18	<u>1/2</u>	BOTTOM OUTLET TO <u>GA-F07</u>
19		LIQUID OUTLET TO
20		DRAWOFF TO
21		RETURN FROM
22		DRAWOFF TO
23		RETURN FROM
24		DRAWOFF TO
25		RETURN FROM
26		REFLUX DRAWOFF TO
27		REFLUX IN FROM
28		REFLUX DRAWOFF TO
29		REFLUX IN FROM
30		PROCESS STEAM
31		STEAM OUT (SO)
32		DRAIN
33		SAMPLE CONN (S) COOLER (CO)
34		SAFETY VALVE (PSV)
35		SAFETY VALVE (PSV) (MSV)
36		UTILITY CONNECTION
37		PRESSURE GAUGE (PG)
38		PRESSURE CONTROLLER (P) _____ Q
39		PRESSURE TAP (PT)
40	<u>2</u>	STEAM COIL
41		TEMPERATURE INDICATOR (TI)
42		TEMPERATURE CONTROLLER (T) _____ Q
43		TEMPERATURE RECORDER (TR)
44		TEMPERATURE WELL (TW)
45	<u>1</u>	GAUGE MAIN
46		GAUGE GLASS (GG)
47		EXTERNAL LEVEL
48		INTERNAL LEVEL
49		LEVEL ALARM (LA)
50		

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO



NOTES 1) SULFURIC ACID SP GR = 184

2) STEAM COIL TO MAINTAIN 50°F MIN

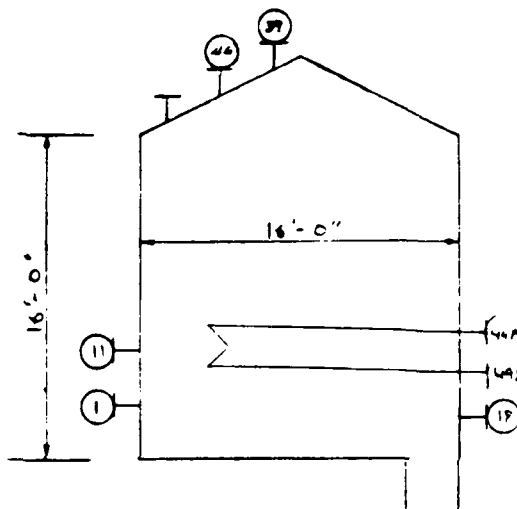
		THE LUMMUS COMPANY Houston	
TITLE <u>JET FUEL PROJECT</u>			
CLIENT <u>Phillips 66</u> <u>SEAT LOCATION</u> <u>PLANT</u> <u>SEAT</u> <u>PLANT</u> PROJ NO <u>05571</u>			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	DESIGNED BY <u>FB-F01</u> CHECKED BY _____ APPROVED BY _____

VESSEL NO FB-802 CODES WITH
 VESSEL NAME TFW DAY TANK
 DIAMETER 16'-0" R-4 S
 VERT HT 16'-0" R-4 BURT
 HORIZ LENGTH
 OPER TEMP TOP 150 BOT 150 DRAIN 150
 MAX TEMP TOP 150 BOT 150 DRAIN 150
 NORM OPER PRESS PSIG OR PSIA
 MAX OPER PRESS PSIG OR PSIA
 CORROSION ALLOW: SHELL 1/8" R. DECK 1/8"
 DES TEMP 230
 DES PRESS PSIG H₂O PSIG VAC -2" H₂O PSIG
 HEADS SLIP SEWED CONC FLAT 10'-0"
 CODE ASME API OTHER
 STRESS RELIEVED YES CODE
 RADIOGRAPHED YES CODE
 EARTHQUAKE WIND PSIG
 MATL SHELL CS LINER THK
 INSULATION CONSERV PROTECT NONE
 DECK MATL

NOZZLES FLO CLASS 150 COUPL. CLASS

ITEM NO	SIZE	SERVICE & SYMBOL
1	2"	MANHOLE
2		MANHOLE
3		
4		
5		MANHOLE
6		
7		VAPOR OUTLET TO
8		VENT
9		TO VACUUM EQUIPMENT
10		REFLUX IN FROM
11	2"	FEED FROM <u>GA-824</u>
12		FEED FROM
13		FEED FROM
14		TO REBOILER (RES. PUMP)
15		FROM REBOILER
16		SQUALIZING LINE WITH
17		BOTTOM OUTLET TO
18	2"	LIQUID OUTLET TO <u>GA-824</u>
19		DRAWOFF TO
20		RETURN FROM
21		DRAWOFF TO
22		RETURN FROM
23		DRAWOFF TO
24		RETURN FROM
25		REFLUX DRAFF TO
26		REFLUX IN FROM
27		REFLUX DRAFF TO
28		REFLUX IN FROM
29		PROCESS STEAM
30		STEAM OUT (BO)
31		DRAIN
32		SAMPLE (BOH) (B. COOLER) (BO)
33		SAFETY VALVE (PSV)
34		SAFETY VALVE (PSV) (NSV)
35		UTILITY CONNECTION
36		PRESSURE GAGE (PG)
37		PRESSURE CONTROLLER (P) <u>Q</u>
38		PRESSURE TAP (PT)
39	1/2"	<u>AS CHANGING</u>
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (T) <u>Q</u>
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44	1"	<u>GAUGE</u>
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49	2"	STEAM COIL
50		

PLANNED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 80 TO NOZZLE NO



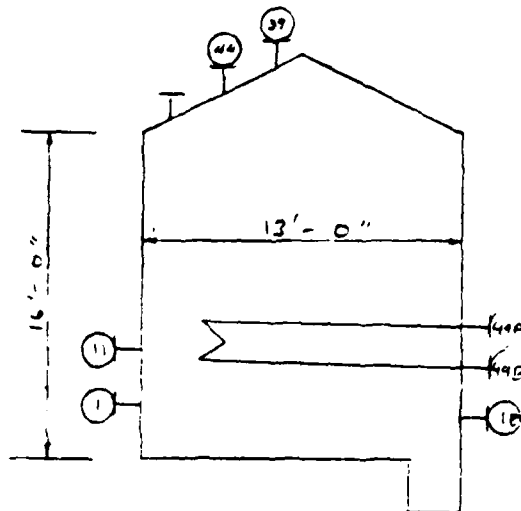
- NOTES
 1) LIQUID SP. GR = 0.96 @ operat. temp.
 2) STEAM COIL TO MAINTAIN 150°F TEMP.

		THE LUBRIZOL COMPANY Cleveland	
THE JET FUEL PROTECT CHEMICALS/PRODUCTS DIVISION CLEVELAND, OH PRODUCT NO. 65571			
PREPARE VESSEL SHEET			
VESSEL NO FB-802	TITLE FUEL TANK	DATE 10/1/71	DRAWN BY JH

VESSEL NO. FC-800 COMB WITH _____
 VESSEL NAME PHENOL TAN TANK
 DIAMETER 13'-0" R-AN 8
 VENT HT 16'-0" R-AN BRUNT
 HORIZ LENGTH _____ R-AN _____
 OPER TEMP TOP _____ ° BOTM _____ ° DRUM 122 °
 MAX TEMP TOP _____ ° BOTM _____ ° DRUM _____ °
 NORM OPER PRESS _____ PSI OR _____
 MAX OPER PRESS _____ PSI OR _____
 CORROSION ALLOW SHELL 3/8" IN DECKS _____ IN
 DES TEMP 230 °
 DES PRESS 1.0 PSI VAC -2 H₂O PSI
 HEADS ELIP _____ DISHD _____ CONE ROOF FLAT BOTTOM
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ PSI
 MATL SHELL CS LINER _____ THK _____ IN
 INSULATION CONSERV ✓ PROTECTN _____ NONE
 DECK MATL _____
 NOZZLES FLG CLASS 150 COUP CLASS _____

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1	1	2"	MANHOLE
2			MANHOLE
3			
4			
5			HANDHOLE
6			
7			VAPOR OUTLET TO
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11	1	1/2"	FEED FROM <u>GA-818</u>
12			FEED FROM
13			FEED FROM
14			TO REBOILER (RES PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH
17			BOTTOM OUTLET TO
18			LIQUID OUTLET TO <u>GA-819</u>
19			DRAWOFF TO
20			RETURN FROM
21			DRAWOFF TO
22			RETURN FROM
23			DRAWOFF TO
24			RETURN FROM
25			REFLUX DRAWOFF TO
26			REFLUX IN FROM
27			REFLUX DRAWOFF TO
28			REFLUX IN FROM
29			PROCESS STEAM
30			STEAM OUT (BOI)
31			DRAIN
32			SAMPLE CONN (S), COOLER (C)
33			SAFETY VALVE (PSV)
34			SAFETY VALVE (PSV), (MSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PG)
37			PRESSURE CONTROLLER (P) _____ (C)
38			PRESSURE TAP (PT)
39	1	1/2"	<u>NO FLANGE TUG</u>
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T) _____ (C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44	1	4"	<u>GAUGE - 150"</u>
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49	2		<u>STEAM COIL</u>
50			

FLANGED NOZZLES ARE
 NUMBERED 1-80
 FOR COUPLING ADD
 80 TO NOZZLE NO



NOTES

- 1) LTG 30.50 GR = 103 @ operating temp
- 2) STEAM COIL TO MAINTAIN 122°F TEMP.

		THE LUMMUS COMPANY	
		Houston	
TITLE <u>JET FUEL PROTECT</u> QUANTITY <u>AMBLD/DOE</u> LOCATION <u>BEULAH, ND</u> GREAT PLAINS <u>PLANT</u> <u>PLANT</u> PROJ NO <u>05571</u>			
PROCESS VESSEL SKETCH			
REV	DATE	BY	APPV
1	11/11/58	For Tank 4	
VESSEL NO <u>FE-803</u>		DWG. SHEET	

VESSEL NO. FR-804 A, B, C, D
 VESSEL NAME 100 FT W ST-2 AG-1
 DIAMETER 30'-0" R-4
 VERT HT 32'-0" R-4
 NOZZLE LENGTH 150 R-4
 OPER TEMP TOP 150 °F BOTT 150 °F DRUM 150 °F
 MAX TEMP TOP 150 °F BOTT 150 °F DRUM 150 °F
 NORM OPER PRESS 150 PSIG OR 150 PSIA
 MAX OPER PRESS 150 PSIG OR 150 PSIA
 CORROSION ALLOW SHELL 1/8" IN DECK 1/8" IN

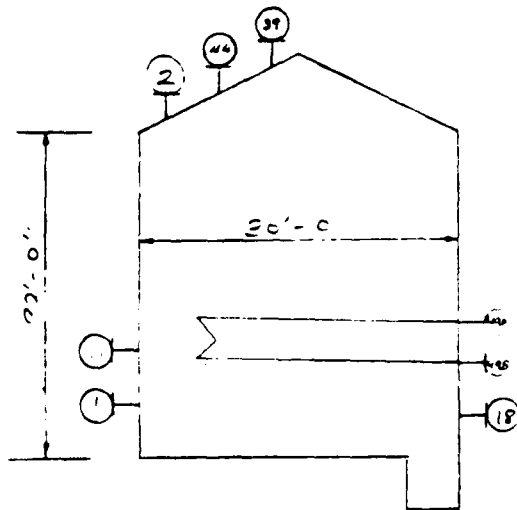
DES TEMP 230 °F
 DES PRESS 150 PSIG VAC -2" H₂O PSIA
 HEADS ELIP DISHD DOME FLAT FLAT TO M
 CODE ASME API OTHER OTHER
 STRESS RELIEVED YES CODE
 RADIOGRAPHED YES CODE
 EARTHQUAKE WIND WIND WIND

MATL SHELL LINEA TMR IN
 INSULATION CONSERV'N PROTECTN NONE
 DECK MATL

NOZZLES FLG CLASS 150 COUPL CLASS

ITEM NO	SIZE	SERVICE & SYMBOL
1	24"	MANHOLE
2	24"	MANHOLE
3		
4		
5		MANHOLE
6		
7		VAPOR OUTLET TO
8		VENT
9		TO VACUUM EQUIPMENT
10		REFLUX IN FROM
11		FEED FROM <u>ST-2</u>
12		FEED FROM
13		FEED FROM
14		TO REBOILER (RE PUMP)
15		FROM REBOILER
16		EQUALIZING LINE WITH
17		BOTTOM OUTLET TO
18		LIQUID OUTLET TO
19		DRAWOFF TO
20		RETURN FROM
21		DRAWOFF TO
22		RETURN FROM
23		DRAWOFF TO
24		RETURN FROM
25		REFLUX DRAFF TO
26		REFLUX IN FROM
27		REFLUX DRAFF TO
28		REFLUX IN FROM
29		
30		PROCESS STEAM
31		STEAM OUT (SO)
32		DRAIN
33		SAMPLE CONN (S) COOLER (C)
34		SAFETY VALVE (SV)
35		SAFETY VALVE (SV) (NSV)
36		UTILITY CONNECTION
37		PRESSURE GAGE (PG)
38		PRESSURE CONTROLLER (P) <u>G</u>
39		PRESSURE TAP (PT)
40		<u>TEMP INDICATOR (TI)</u>
41		TEMPERATURE CONTROLLER (T) <u>G</u>
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44		<u>GAUGE GLASS (GG)</u>
45		EXTERNAL LEVEL
46		INTERNAL LEVEL
47		LEVEL ALARM (LA)
48		<u>STEAM COIL</u>
49		
50		

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO



NOTES

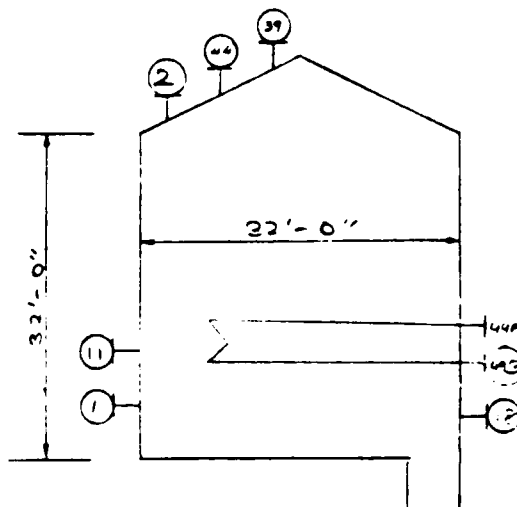
- 1) LIQUID SG GR = 0.98
- 2) STEAM COIL TO MAINTAIN 150°F

		THE LUMMUS COMPANY	
		Birmingham	
THIS JET FUELS PROJECT QUANTICO/DOE ORIGINATOR BEULAH AND PLANT BEULAH PLANT PROJ NO 05671			
PROCESS VESSEL SKETCH			
REV	DATE	BY	CHK
1	1/1/68	FOR TASK 4	KL
2	1/1/68	FOR TASK 4	KL
3	1/1/68	FOR TASK 4	KL
4	1/1/68	FOR TASK 4	KL
5	1/1/68	FOR TASK 4	KL
6	1/1/68	FOR TASK 4	KL
7	1/1/68	FOR TASK 4	KL
8	1/1/68	FOR TASK 4	KL
9	1/1/68	FOR TASK 4	KL
10	1/1/68	FOR TASK 4	KL
11	1/1/68	FOR TASK 4	KL
12	1/1/68	FOR TASK 4	KL
13	1/1/68	FOR TASK 4	KL
14	1/1/68	FOR TASK 4	KL
15	1/1/68	FOR TASK 4	KL
16	1/1/68	FOR TASK 4	KL
17	1/1/68	FOR TASK 4	KL
18	1/1/68	FOR TASK 4	KL
19	1/1/68	FOR TASK 4	KL
20	1/1/68	FOR TASK 4	KL
21	1/1/68	FOR TASK 4	KL
22	1/1/68	FOR TASK 4	KL
23	1/1/68	FOR TASK 4	KL
24	1/1/68	FOR TASK 4	KL
25	1/1/68	FOR TASK 4	KL
26	1/1/68	FOR TASK 4	KL
27	1/1/68	FOR TASK 4	KL
28	1/1/68	FOR TASK 4	KL
29	1/1/68	FOR TASK 4	KL
30	1/1/68	FOR TASK 4	KL
31	1/1/68	FOR TASK 4	KL
32	1/1/68	FOR TASK 4	KL
33	1/1/68	FOR TASK 4	KL
34	1/1/68	FOR TASK 4	KL
35	1/1/68	FOR TASK 4	KL
36	1/1/68	FOR TASK 4	KL
37	1/1/68	FOR TASK 4	KL
38	1/1/68	FOR TASK 4	KL
39	1/1/68	FOR TASK 4	KL
40	1/1/68	FOR TASK 4	KL
41	1/1/68	FOR TASK 4	KL
42	1/1/68	FOR TASK 4	KL
43	1/1/68	FOR TASK 4	KL
44	1/1/68	FOR TASK 4	KL
45	1/1/68	FOR TASK 4	KL
46	1/1/68	FOR TASK 4	KL
47	1/1/68	FOR TASK 4	KL
48	1/1/68	FOR TASK 4	KL
49	1/1/68	FOR TASK 4	KL
50	1/1/68	FOR TASK 4	KL

VESSEL NO FR-805 A.B.
 VESSEL NAME PHENOL MOUNT STORAGE
 DIAMETER 32'-0" R-H &
 VERT HT 32'-0" R-H SHORT
 NOZZLE LENGTH
 OPER TEMP TOP 122 °F BOT 122 °F DRAIN 122 °F
 MAX TEMP TOP 122 °F BOT 122 °F DRAIN 122 °F
 NORM OPER PRESS 100 PSIG OR 100 PSIA
 MAX OPER PRESS 100 PSIG OR 100 PSIA
 CORROSION ALLOW SHELL 2 IN DECKS 2 IN
 DES TEMP 230 °F
 DE PRESS 5 H₂O 100 PSIG VAC -2 VAC
 HEADS ELIP DISHD CONE FLAT
 CODE ASME API OTHER
 STRESS RELIEVED YES CODE
 RADIOGRAPHED YES CODE
 EARTHQUAKE YES WIND
 MATL SHELL CS LINER TBR IN
 INSULATION CONSERV PROTECT NONE
 DECK MATL ISO
 NOZZLES FLS CLASS COUPL CLASS

ITEM NO	SIZE	SERVICE & SYMBOL
1	2"	MANHOLE
2	2"	MANHOLE
3		
4		
5		MANHOLE
6		
7		VAPOR OUTLET TO
8		VENT
9		TO VACUUM EQUIPMENT
10		REFLUX IN FROM
11	2"	FEED FROM <u>GP-819</u>
12		FEED FROM
13		FEED FROM
14		TO REBOILER (REB PUMP)
15		FROM REBOILER
16		SQUALIZING LINE WITH
17		BOTTOM OUTLET TO
18	2"	LIQUID OUTLET TO
19		DRAFF TO
20		RETURN FROM
21		DRAFF TO
22		RETURN FROM
23		DRAFF TO
24		RETURN FROM
25		REFLUX DRAFF TO
26		REFLUX IN FROM
27		REFLUX DRAFF TO
28		REFLUX IN FROM
29		PROCESS STEAM
30		STEAM OUT ISO
31		DRAIN
32		SAMPLE CONN (S), COOLER (C)
33		SAFETY VALVE (PSV)
34		SAFETY VALVE (PSV) IN SV
35		UTILITY CONNECTION
36		PRESSURE GAUGE (PG)
37		PRESSURE CONTROLLER (P) <u>Q</u>
38		PRESSURE TAP (PT)
39	1/4"	<u>NO. 81-154-100</u>
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (T) <u>Q</u>
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44	1"	<u>ORNG - MATL</u>
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49	2"	<u>STEAM COIL</u>
50		

FLANGED NOZZLES ARE
 NUMBERED 1-80
 FOR COUPLING ADD
 80 TO NOZZLE NO



NOTES

- 1) LIQUID SP GR = 1.03
- 2) STEAM COIL TO MAINTAIN 122°F TEMP

		THE LUMMUS COMPANY Houston	
TITLE <u>JET FUEL PROJECT</u> CLIENT <u>AMCO/DOE</u> LOCATION <u>OSULAN, ND</u> PROJ NO <u>05571</u>			
PROCESS VESSEL SKETCH			
REV	DATE	BY	APP
1		FL TANK 4	
VESSEL NO <u>FR-805</u>		DRAWN BY	

PUMP NO.	PUMP TYPE	PUMP TYPE	LUBRICANT	CORR. AT NO.	PUMPING TEMP. °F	VISC. AT P. °F	VISC. AT P. °F	VISC. AT P. °F	CAPACITY LBS/MIN	DRAIN PRESS. PSI	SUCTION PRESS. PSI	DIFF. PRESS. PSI	DIFF. HEAD FT.	DIFF. HEAD FT.	MOT. AVAIL. CLASS	CORR. ALLOW. IN	FLAME RATING/ACC. SUCT.	DRIVER TYPE	REMARKS
GA-801A	Compressor	Compressor	Oil	122	1.02	1.5	0.86	0.86	25.5	55	0.1	55	123	29	DE-1			MOTOR	
GA-802A	Compressor	Compressor	Oil	194	0.99	1.9	0.47	0.47	77	67	-9.7	77	178	67	DE-1			MOTOR	
GA-803A	Compressor	Compressor	Oil	446	0.93	7.7	0.3	0.3	10	40	-2.3	42	95	115	DE-1			MOTOR	
GA-804A	Compressor	Compressor	Oil	358	0.93	1.5	0.67	0.67	15	39	-10	49	119	66	DE-1			MOTOR	
GA-805A	Compressor	Compressor	Oil	122	0.99	0.8	0.67	0.67	35	42	-10	52	122	8	DE-1			MOTOR	
GA-806A	Compressor	Compressor	Oil	105	1.8	4.1	0.33	0.33	15	33	-7.8	40	51	177	DE-1			MOTOR	
GA-807A	Compressor	Compressor	Oil	395	0.94	4.2	0.33	0.33	15	33	-7.8	41	100	65	DE-1			MOTOR	
GA-808A	Compressor	Compressor	Oil	372	0.94	1.5	0.38	0.38	10	12	-5	42	113	34	DE-1			MOTOR	
GA-809A	Compressor	Compressor	Oil	122	0.94	1.5	0.38	0.38	20	36	-7.3	26	66	115	DE-1			MOTOR	
GA-810A	Compressor	Compressor	Oil	122	0.94	0.8	0.47	0.47	1	11	-10.7	50	120	87	DE-1			MOTOR	
GA-811A	Compressor	Compressor	Oil	122	1.05	1.0	0.67	0.67	11	12	-10.7	51	113	68	DE-1			MOTOR	
GA-812A	Compressor	Compressor	Oil	212	0.91	1.9	0.36	0.36	140	168	-10.3	95	215	65	DE-1			MOTOR	
GA-813A	Compressor	Compressor	Oil	309	0.95	6.1	0.31	0.31	8	9	-5.9	76	183	64	DE-1			MOTOR	
GA-814A	Compressor	Compressor	Oil	315	0.94	6.7	0.29	0.29	10	12	-1.5	69	176	114	DE-1			MOTOR	
GA-815A	Compressor	Compressor	Oil	122	1.04	0.7	0.47	0.47	11	12	-10.7	51	113	68	DE-1			MOTOR	
GA-816A	Compressor	Compressor	Oil	248	0.97	0.8	0.4	0.4	16	18	-5.2	61	145	116	DE-1			MOTOR	
GA-817A	Compressor	Compressor	Oil	122	0.97				60	25	-0.6	26	60	32	DE-1			MOTOR	
GA-818A	Compressor	Compressor	Oil	122	0.94	1.0			16	24	-1.0	20	74	2	DE-1			MOTOR	

UTILITIES

COOLING WATER: SUPPLY PRESS. PSI, TEMP. °F, RETURN PRESS. PSI, TEMP. °F, MAKEUP WATER PRESS. PSI, TEMP. °F

STEAM: SUPPLY PRESS. PSI, TEMP. °F, RETURN PRESS. PSI, TEMP. °F, MAKEUP WATER PRESS. PSI, TEMP. °F

HEATING: SUPPLY PRESS. PSI, TEMP. °F, RETURN PRESS. PSI, TEMP. °F, MAKEUP WATER PRESS. PSI, TEMP. °F

AREA CLASS: ON, OFF, BY

THE LUMBER COMPANY

PUMP SCHEDULE

AMSD/DOE - 60647

CUSTOMER PLANT: GOSL. DOW PROJECT JET FUEL

UNIT: AREA 800

DATE: 4/9/89

REV. NO. 0

JOB NO. 05571

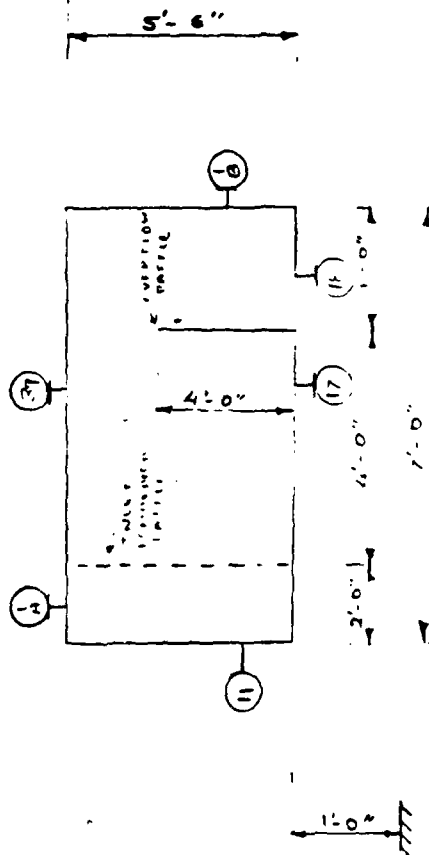
PUMP NO.	SERVICE	PUMP TYPE	LIQUID	CONNECTIONS	PUMPING TEMP. °F	SPEC. GRAVITY	VISC. AT P.T. CP	CAPACITY GPM	DISCH. PRESS. PSIG	SUCTION PRESS. PSIG	DIFF. PRESS. PSIG	DISCH. HEAD FT	SUCTION HEAD FT	CORR. ALLOW. IN	FLANGE RATING/ACTING	DRIVER TYPE	REMARKS
GR-232A	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232B	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232C	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232D	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232E	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232F	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232G	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232H	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232I	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232J	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232K	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232L	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232M	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232N	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232O	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232P	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232Q	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232R	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232S	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232T	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232U	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232V	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232W	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232X	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232Y	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	
GR-232Z	WATER PUMP	CENTRIFUGAL	WATER	1" NPT	121	1.0	0.49	16.0	2.0	2.0	2.0	60	2.0	2.0	2.0	2.0	

VESSEL NO. F.D. 701 COND WITH 1
 VESSEL NAME 1ST STAGE WATER WASH TANK
 DIAMETER 48" ID 48" OD 48" ID
 VERT HT. 10' 0" 10' 0" 10' 0"
 NOZZLE LENGTH 10' 0" 10' 0" 10' 0"
 OPER TEMP TOP 100°F 100°F 100°F
 MAX TEMP TOP 100°F 100°F 100°F
 NORM OPER PRESS 0 0 0
 MAX OPER PRESS 0 0 0
 CORROSION ALLOW 0.125" 0.125" 0.125"
 DES TEMP 100°F 100°F 100°F
 DES PRESS 0 0 0
 HEADS: DWP DRUM DRUM DRUM FLAT
 CODE: AGME API API API OTHER
 STRESS RELIEVED YES NO NO NO OTHER
 RADIOGRAPHED YES NO NO NO OTHER
 SEISMICALLY NO NO NO OTHER
 MATL: SHELL SAE 1010 SAE 1010 SAE 1010 OTHER
 INSULATION CONSTRUCTION PROTECTIVE PROTECTIVE PROTECTIVE OTHER
 DESK MATL: NO NO NO OTHER

LENGTH = 7'-0"
 WIDTH = 4'-6"
 DEPTH = 5'-6"

ITEM NO.	SIZE	SERVICE & SYMBOL
1	1/2"	HANDHOLE
2	1/2"	HANDHOLE
3	1/2"	HANDHOLE
4	1/2"	HANDHOLE
5	1/2"	HANDHOLE
6	1/2"	HANDHOLE
7	1/2"	VAPOR OUTLET TO VENT
8	1/2"	TO VACUUM EQUIPMENT
9	1/2"	REFILL IN FROM
10	1/2"	FEED FROM <u>FEED (2-12)</u>
11	1/2"	FEED FROM
12	1/2"	FEED FROM
13	1/2"	FEED FROM
14	1/2"	TO PRECOOLER REE. PUMP
15	1/2"	FROM RECOILER
16	1/2"	REMAINDER LINE WITH
17	1/2"	BOTTOM OUTLET TO <u>GB-12</u>
18	1/2"	LIQUID OUTLET TO <u>GB-12</u>
19	1/2"	DRAWOFF TO
20	1/2"	RETURN FROM
21	1/2"	DRAWOFF TO
22	1/2"	RETURN FROM
23	1/2"	DRAWOFF TO
24	1/2"	RETURN FROM
25	1/2"	REPLINE DRAWOFF TO
26	1/2"	REPLINE IN FROM
27	1/2"	REPLINE DRAWOFF TO
28	1/2"	REPLINE IN FROM
29	1/2"	PROCESS STEAM
30	1/2"	STEAM OUT (S)
31	1/2"	STEAM
32	1/2"	SAMPLE COOL. (S) COOLER (S)
33	1/2"	SAFETY VALVE (SV)
34	1/2"	SAFETY VALVE (SV) (NOV)
35	1/2"	UTILITY CONNECTION
36	1/2"	PRESSURE GAGE (PG)
37	1/2"	PRESSURE CONTROLLER (PC)
38	1/2"	PRESSURE TAP (PT)
39	1/2"	<u>NO GLASS-ING</u>
40	1/2"	TEMPERATURE REGULATOR (TR)
41	1/2"	TEMPERATURE CONTROLLER (TC)
42	1/2"	TEMPERATURE RECORDER (TR)
43	1/2"	TEMPERATURE WELL (TW)
44	1/2"	GAUGE GLASS (GG)
45	1/2"	EXTERNAL LEVEL
46	1/2"	INTERNAL LEVEL
47	1/2"	LEVEL ALARM (LA)
48	1/2"	
49	1/2"	
50	1/2"	

FLANGED NOZZLES ARE
 DIMENSIONED FOR
 PER COUPLING ADD
 50 TO NOZZLE NO



LEGEND: 1/2" = 0.97 (avg); 2" opening temp

		THE LUMMUS COMPANY Houston	
WILCOX FUEL PROTECT 6100 AMING/201 GROUNDWATER BEULAH, ND PLANT 6100 PLANT 6100 0571			
PROCESS VESSEL SKETCH			
VESSEL NO. <u>F.D. 701</u>		DESK NO. <u>-</u>	

REV	DATE	DESCRIPTION	PRICE	QUANTITY	AMOUNT	AMOUNT
1	1/1/74	FOR TANK 4	12			

LENGTH = 7'-0"
WIDTH = 4'-6"
DEPTH = 5'-6"

5'-6"


Diagram of a rectangular structure with dimensions and labels:

- Overall width: 7'-0"
- Overall height: 4'-0"
- Internal width (left section): 2'-0"
- Internal width (right section): 4'-0"
- Internal height (left section): 4'-0"
- Internal height (right section): 4'-0"
- Labels:
 - Top left: 31
 - Top right: 18
 - Bottom left: 7
 - Bottom right: 11
 - Top center: 16
 - Bottom center: 17
 - Left side: 31
 - Right side: 18
 - Top edge: 16
 - Bottom edge: 17
 - Left section: 2'-0"
 - Right section: 4'-0"
 - Top section: 4'-0"
 - Bottom section: 4'-0"
 - Left section label: 31
 - Right section label: 18
 - Top section label: 16
 - Bottom section label: 17

ITEM NO.	NO. REQD	SIZE	SERVICE & SYMBOL
1	2	1/2	MANHOLE
2			MANHOLE
3			
4			
5			MANHOLE
6			
7			VAPOR OUTLET TO
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11	H	H	FEED FROM GA-822
12			FEED FROM
13			FEED FROM
14			FEED FROM
15			TO REBOILER (HEAT PUMP)
16			FROM REBOILER
17	H	H	SOLUBLE LINE WITH
18			BOTTOM OUTLET TO GA-822
19			LIQUID OUTLET TO GA-822
20			DRAFFOFF TO
21			RETURN FROM
22			DRAFFOFF TO
23			RETURN FROM
24			DRAFFOFF TO
25			RETURN FROM
26			REFLUX DRAFFOFF TO
27			REFLUX IN FROM
28			REFLUX DRAFFOFF TO
29			REFLUX IN FROM
30			PROCESS STEAM
31			STEAM OUT (S)
32			DRAIN
33			SAMPLE COOL. (S) COOLER (S)
34			SAFETY VALVE (SV)
35			SAFETY VALVE (SV) (N)
36			UTILITY CONNECTION
37			PRESSURE BASE (P)
38			PRESSURE CONTROLLER P
39	H	1/2	PRESS TAP (T)
40			TEMPERATURE REGULATOR (R)
41			TEMPERATURE CONTROLLER (C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			
45			GRADE CLASS (S)
46			INTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

WGLD sp. GR = 0.97 (avg) @ operating temp.

▲									
▲	6/14/87	FOR TAX 4							
REV	ISSUE DATE	DESCRIPTION							

 LUMMUS	THE LUMMUS COMPANY Stamford
WILL JET FUEL PROTECT GULF AND/OR DDE CORROSION BEULAH, ND PLASMA CRYSTAL PLANT AND NO 05571 FROM NO	
PROCESS VESSEL SKETCH	
FD-802	(PENG. CAR

DA-804 STRIPPING COLUMN

COLUMN HEIGHT (T-T) 100'-0"

SHELL MATL: CS LINER: 316L SS CLAD
VALVE MATL: 304 SS

CAPACITY 135 ft³

EA-810 STRIPPING COL. CONDENSEN

SURFACE AREA: 1050 ft^2

SHELL MATL: CS CORR ALLOW 45 mi-
TUBE MATL: CS 3mm

EF-814 : STIPPLING COL. SIDE RECOILED
(KETTLE TYPE)

SURFACE AREA : 450 m^2

SHELL MATL. CS CORR. ALLOW 4.5mm
TUBE MATL: CS 3mm

[illegible]

A106 03 0776-1 REV.1

JOB JET FUEL PROJ ACCT. 05371

MATL: 316L SS or CS WITH 316L SS CLAD

[illegible]

F-133



THE LUMMUS COMPANY
Bloomfield

Always refer to this number

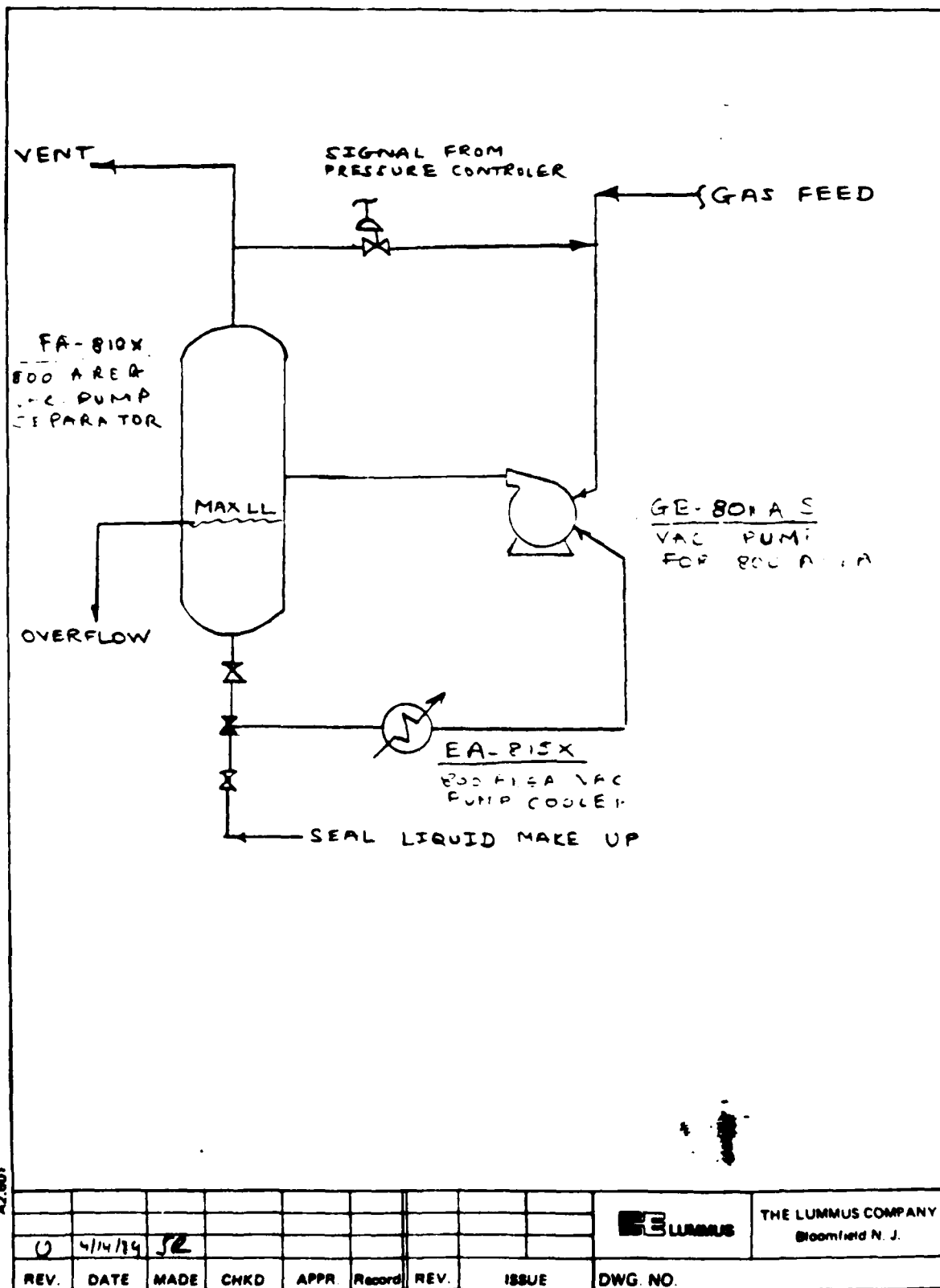
DATA SHEET - LIQUID RING VACUUM PUMP

Div. Job PO/Req. Sup

1	APPLICABLE TO	<input type="radio"/> PROPOSAL	<input type="radio"/> PURCHASE	<input type="radio"/> AS BUILT	ITEM NO	G2801A KS		
2	FOR AMCO/LOF - JET FUEL PROTECT				UNIT			
3	SITE				DRIVER			
4	SERVICE VACUUM PUMP FOR 800 AREA NO REQUIRED							
5	MANUFACTURER	MODEL			SERIAL NO.			
6	NOTE	<input type="radio"/> INDICATES INFORMATION TO BE COMPLETED BY PURCHASER					<input type="checkbox"/> BY MANUFACTURER	
7								
8	OPERATING CONDITIONS							
9	(ALL DATA ON PER UNIT BASIS)			OTHER CONDITIONS				
10		NORMAL	RATED	A	B	C	RUN-IN	
11	<input type="radio"/> GAS HANDLED (Also See Page 3 of 3)							
12	<input type="radio"/> MMSCFD/SCFM (14.7 psia & 60°F dry)							
13	<input type="radio"/> WEIGHT FLOW (lb/min) - (Wet) - (Dry)		2					
14	INLET CONDITIONS:							
15	<input type="radio"/> PRESSURE (psia) *		0.37					
16	<input type="radio"/> TEMPERATURE (°F)		160					
17	<input type="radio"/> RELATIVE HUMIDITY (%)							
18	<input type="radio"/> MOLECULAR WEIGHT (MI)		29.9					
19	<input type="checkbox"/> n_g (Path Exponent, PTC-10) (Kp/Cv)		1.39					
20	<input type="checkbox"/> COMPRESSIBILITY (Z1) OR (Zavg)		1.0					
21	<input type="checkbox"/> INLET VOLUME (cfm-WET) *		734					
22	DISCHARGE CONDITIONS:							
23	<input type="radio"/> PRESSURE (psia) *		22.1					
24	<input type="radio"/> TEMPERATURE (°F)							
25	<input type="checkbox"/> n_g (Path Exponent, PTC-10)							
26	<input type="checkbox"/> COMPRESSIBILITY (Z2) OR (Zavg)		1.0					
27								
28	<input type="checkbox"/> bhp REQUIRED (At Losses Incl.)							
29	<input type="checkbox"/> SPEED (rpm)							
30	<input type="checkbox"/> PRESSURE RATIO (R)							
31	<input type="checkbox"/> VOLUMETRIC EFFICIENCY (%)							
32	<input type="checkbox"/> SILENCER ΔP (psi) INLET/DISCHARGE	/	/	/	/	/	/	
33	<input type="checkbox"/> PERFORMANCE CURVE NO.							
34	PROCESS CONTROL:							
35	METHOD	<input type="radio"/> BYPASS FROM		TO	<input type="radio"/> BYPASS: <input type="radio"/> MANUAL <input type="radio"/> AUTO			
36		<input type="radio"/> SPEED VARIATION FROM		TO				
37		<input type="radio"/> OTHER						
38	SIGNAL	<input type="radio"/> SOURCE						
39		<input type="radio"/> TYPE						
40		<input type="radio"/> RANGE FOR PNEUMATIC CONTROL		rpm AT	psig AND	rpm AT	psig	
41	OTHER							
42								
43								
44								
45								
46								
47								
48								
49								
50								
51								
52	* AT CUSTOMER CONNECTIONS TO SILENCERS							
53	Prepared: 5/2	Approved:	Date: 4/14/85 A	Rev. Δ	Rev. Δ	Rev. Δ		

A100 M 0787-TP2 5.1/1 REV 4

PA-EG1
 DESIGN COMPUTATIONS FOR VACUUM PACKAGE FOR 800 AREA
 JOB _____ ACCT. 05571



A105 03 0776-1 REV 1

DESIGN COMPUTATIONS FOR PA-801
VACUUM PACKAGING FOR 800 AREA
 JOB _____ ACCT. 05571

COMPONENT	GAS FEED WT%
AIR	85.0
PHENOL	1.0
H ₂ O	3.0
SO ₂	11.0

REV.	DATE	MADE	CHKD.	APPR.	Record	REV.	ISSUE	DWG. NO.
0	4/4/19	S/R						

THE LUMMUS COMPANY
 Bloomfield, N. J.

A105 03 0776-1 REV.1

AREA 850

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571

DATE/BY: 21-Mar-89
08:54 AM

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

HEATERS

TOWERS

INTERNALS

REACTORS

EXCHANGERS

VESSELS

TANKS

FILTERS

PUMPS

COMPRESSORS

PACKAGE UNITS

TOTAL

4	\$115	100%	\$115	
	\$281			
11	\$167	120%	\$200	
9	\$25	120%	\$30	
3	\$127	80%	\$102	
23	\$173	110%	\$190	
50	\$888		\$637	

SUMMARY

EQUIPMENT

\$888

COMMODITIES

\$637

LABOR

\$471 (10% EQUIP, 60% COMM)

INDIRECTS

\$471 (100% LABOR)

ENGINEERING

\$2,000 (800/PC X \$50)

SUBTOTAL

\$4,468

CONTINGENCY

\$894 (20%)

TOTAL

\$5,361

EQUIPMENT SUMMARY

DA-851 EXTRACTOR COL.
DA-852 HEXANE COL.
DA-853 METHANOL COL.
DA-854 DRYING COL.

<u>WEIGHT</u>	<u>MATL.</u>	<u>\$/LB</u>	<u>\$</u>
16000	CS	\$1.80	\$28,800
15000	CS	\$1.80	\$27,000
9000	CS	\$2.20	\$19,800
6000	SS	\$6.50	\$39,000
TOTAL			\$114,600

DB-851 EXTRACTOR COL.
DB-852 HEXANE COL.
DB-853 METHANOL COL.
DB-854 DRYING COL.

<u>FT2</u>	<u>MATL</u>	<u>\$/FT2</u>	<u>\$</u>
16000	CS	HOLD	\$250,000 (OTTO YORK PRORA
400	CS	\$40.00	\$16,000
150	CS	\$40.00	\$6,000
100	SS	\$90.00	\$9,000
TOTAL			\$281,000

	FT2	MATL	\$/FT2	\$
EA-851	665	CS/CS	\$29.00	\$19,285
EA-852	1320	CS/CS	\$15.00	\$19,800
EA-853	17	CS/CS	\$300.00	\$5,100
EA-854	737	CS/18-2	\$28.00	\$20,636
EA-855	910	CS/CS	\$15.00	\$13,650
EA-856	192	CS/CS	\$42.00	\$8,064
EA-857	434	SS/18-2	\$88.00	\$38,192
EA-858	129	SS/SS	\$175.00	\$22,575
EA-859	91	CS/CS	\$75.00	\$6,825
EA-860	106	CS/CS	\$70.00	\$7,420
EA-861	59	CS/CS	\$100.00	\$5,900
		TOTAL		\$167,447

EQUIPMENT SUMMARY

	<u>WEIGHT</u>	<u>MATL</u>	<u>\$/LB</u>	<u>\$</u>
PA-851	2000	CS	\$2.75	\$5,500
PA-852	1000	CS	\$4.00	\$4,000
PA-853	4000	CS	\$2.25	\$9,000
PA-854	2000	CS	\$3.50	\$7,000
		<u>TOTAL</u>		<u>\$25,500</u>

PA-851 HEXANE REFLUX DRUM
PA-852 METHANOL COL. REFLUX DRUM
PA-853 DRYING COL. REFLUX DRUM
PA-854 METHANOL MAKEUP DRUM

F-140

DOE JET FUEL

FB-851 HEXANE STORAGE TANK
 FB-852 CRUDE CRESYLIC ACID DAY TANK
 FB-853A CRUDE CRESYLIC ACID MONTH TANK

<u>BBL'S</u>	<u>MAT'L</u>	<u>\$/BBL</u>	<u>\$</u>
224	CS	\$55.00	\$12,320
327	CS	\$45.00	\$14,715
2X4176	CS	\$12.00	\$100,224
TOTAL			\$127,259

GA-851, EXTRACTOR BTMS. PUMP
 GA-852, HEXANE COL. BTMS.
 GA-853, HEXANE FEED
 GA-854, HEXANE MAKE UP
 GA-855, METHANOL COL. BTMS
 GA-856, METHANOL COL. REFLUX
 GA-857, DRYING COL. FEED
 GA-858, DRYING COL. BTMS
 GA-859, CRUDE CRESYLIC ACID
 GA-860, DRYING COL. COND.
 GA-861, 65% METHANOL FEED
 GA-862, CRUDE CRYSYLIC ACID FEED

<10HP	CS	\$15,000
<10HP	CS	\$15,000
<10HP	CS	\$15,000
<10HP	CS	\$15,000
<10HP	CS	\$15,000
<10HP	CS	\$15,000
<10HP	CS	\$15,000
<10HP	CS	\$15,000
<10HP	CS	\$15,000
<10HP	CS	\$15,000
<10HP	CS	\$7,500
<10HP	CS	\$15,000
<10HP	CS	\$15,000
<10HP	CS	<u>\$15,000</u>
TOTAL		\$172,500

GD-851 MIXER

INCLUDED W/EXTRACTOR

VESSEL NO. 26-21 COMB WITH _____
 VESSEL NAME 26-21
 DIAMETER 2'-0" H-4 SKIRT H-4
 VERT HT 2'-0" H-4 SKIRT H-4
 HORIZ LENGTH _____
 OPER TEMP TOP 3 °F BOTT 3 °F DRUM 3 °F
 MAX TEMP TOP 3 °F BOTT 3 °F DRUM 3 °F
 NORM OPER PRESS _____ psig OR _____
 MAX OPER PRESS _____ psig OR _____
 CORROSION ALLOW SHELL _____ IN DECKS _____ IN

DES TEMP 3.3 °F
 DES PRESS _____ psig VAC _____ psig
 HEADS ELIP _____ DISHED _____ CONE _____ FLAT _____
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ mph

MATL SHELL _____ LINER _____ THK _____ IN
 INSULATION CONSERVYN _____ PROTECT'N _____ NONE _____
 DECK MATL _____

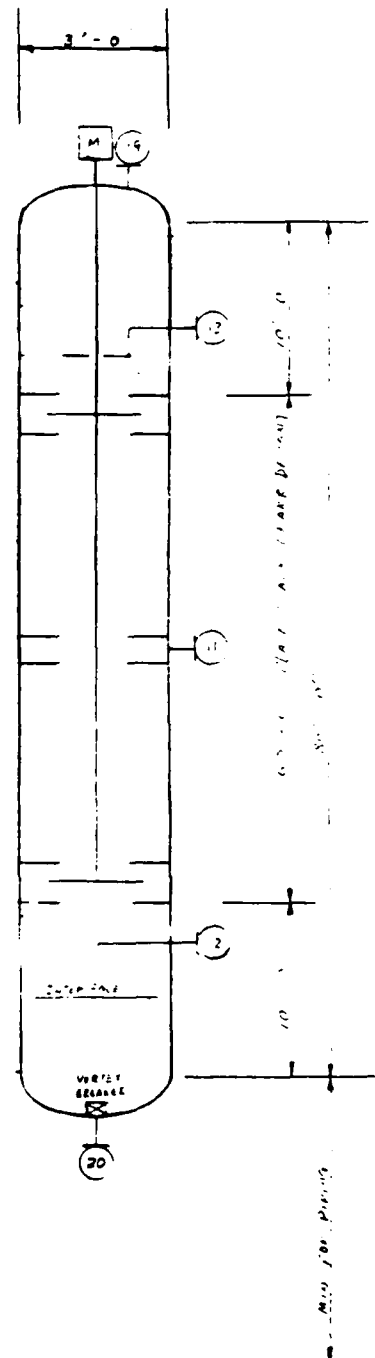
NOZZLES FLG CLASS _____ COUPL CLASS _____

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1	REQD	IN	
2			MANHOLE
3			MANHOLE
4			
5			MANHOLE
6			
7			VAPOR OUTLET TO _____
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM _____
11			FEED FROM <u>26-21</u>
12			FEED FROM <u>26-21</u>
13			FEED FROM <u>26-21</u>
14			TO (REBOILER) (RES PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH _____
17			BOTTOM OUTLET TO _____
18			LIQUID OUTLET TO _____
19			DRAWOFF TO <u>26-21</u>
20			RETURN FROM _____
21			DRAWOFF TO <u>26-21</u>
22			RETURN FROM _____
23			DRAWOFF TO _____
24			RETURN FROM _____
25			REFLUX DRAWOFF TO _____
26			REFLUX IN FROM _____
27			REFLUX DRAWOFF TO _____
28			REFLUX IN FROM _____
29			PROCESS STEAM
30			STEAM OUT (SO)
31			DRAIN
32			SAMPLE CONN (S) COOLER (CO)
33			SAFETY VALVE (PSV)
34			SAFETY VALVE (PSV) (NSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PG)
37			PRESSURE CONTROLLER (P) _____ (C)
38			PRESSURE TAP (PT)
39			
40			TEMPERATURE INDICATOR (TI) _____ (C)
41			TEMPERATURE CONTROLLER (T) _____ (C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO

NOTES

1. 26-21 = 0.75 4.0 1.6 2.0 1.5 1.5
 2. 26-21 = 1.0 1.0 1.0 1.0 1.0



		THE LUMMUS COMPANY	
		Bloomfield	
TITLE <u>26-21 Fuel Project</u>			
CLIENT <u>26-21 Fuel Project</u> LOCATION <u>26-21 Fuel Project</u>			
PROJ NO <u>26-21</u> JOB NO <u>05-21</u>			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	PROJ ENGR
1	1/1/1	FOR TANK 4	1/1
VESSEL NO <u>26-21</u>		DWG NO <u>05-21</u>	

VESSEL NO 2A-252 COMB WITH _____
 VESSEL NAME 2A-252
 DIAMETER 5'-0" IN SKIRT 5'-0" IN
 VERT HT 4'-0" IN SKIRT 5'-0" IN
 HORIZ LENGTH _____
 OPER TEMP TOP 150 °F BOT 150 °F DRUM _____
 MAX TEMP TOP _____ °F BOT _____ °F DRUM _____
 NORM OPER PRESS _____ PSIG OR _____ PSIA
 MAX OPER PRESS _____ PSIG OR _____ PSIA
 CORROSION ALLOW SHELL _____ IN DECK _____ IN

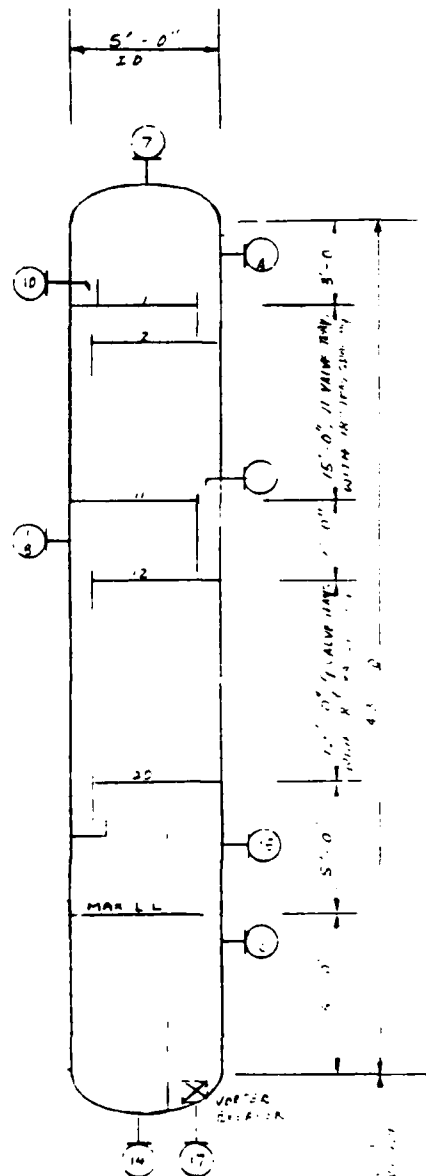
DES TEMP _____ °F
 DES PRESS _____ PSIG VAC _____ PSIG
 HEADS ELIP _____ DISHED _____ CONE _____ FLAT _____
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ MPH

MATL SHELL SS LINER _____ THK _____ IN
 INSULATION CONSERV _____ PROTECTN _____ NONE
 DECK MATL SS VALVES 304SS

NOZZLES FLG CLASS _____ COUPL CLASS _____

ITEM NO	SIZE	SERVICE & SYMBOL
1	2	MANHOLE
2	2	MANHOLE
3		
4		
5		HANDHOLE
6		
7		VAPOR OUTLET TO <u>2A-252</u>
8		VENT
9		TO VACUUM EQUIPMENT
10	4	REFLUX IN FROM <u>2A-252</u>
11	2	FEED FROM <u>2A-252</u>
12		FEED FROM _____
13		FEED FROM _____
14		TO REBOILER (REBOILER) <u>2A-252</u>
15		FROM REBOILER <u>2A-252</u>
16		EQUALIZ NG LINE WITH _____
17	2	BOTTOM OUTLET TO <u>2A-252</u>
18		LIQUID OUTLET TO _____
19		DRAWOFF TO _____
20		RETURN FROM _____
21		DRAWOFF TO _____
22		RETURN FROM _____
23		DRAWOFF TO _____
24		RETURN FROM _____
25		REFLUX DRAWOFF TO _____
26		REFLUX IN FROM _____
27		REFLUX DRAWOFF TO _____
28		REFLUX IN FROM _____
29		PROCESS STEAM
30		STEAM OUT ISO.
31		DRAIN
32		SAMPLE CONN (S) COOLER (C)
33		SAFETY VALVE (PSV)
34		SAFETY VALVE (PSV) (VSV)
35		UTILITY CONNECTION
36		PRESSURE GAGE (PG)
37		PRESSURE CONTROLLER (P) _____ C
38		PRESSURE TAP (PT)
39		
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (T) _____ C
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44		
45		GAUGE GLASS (LG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49		
50		

FLANGED NOZZLES ARE
 NUMBERED 150
 FOR COUPLING ADD
 50 TO NOZZLE NO



NOTES 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50.

				THE LUMMUS COMPANY Houston			
TITLE <u>JET FUEL PROJECT</u>							
CLIENT <u>AMT/256 - 5000 PLUM</u>				LOCATION <u>2A-252</u>			
PROJ NO <u>2A-252</u>				JOB NO <u>15-71</u>			
PROCESS VESSEL SKETCH							
REV	DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR	VESSEL NO <u>2A-252</u>
1	10/1/71	FOR TASK 4					DWG SKS -

VESSEL NO. DA-255 COMB WITH _____
 VESSEL NAME DA-255
 DIAMETER 2'-0" N-IN & _____ N-IN
 VERT HT 42'-0" N-IN SKIRT _____ N-IN
 HORIZ LENGTH _____ N-IN
 OPER TEMP TOP 250 °F BOTT 250 °F DRUM _____ °F
 MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F
 NORM OPER PRESS 15.75 PSIG OR 15.75 PSIA
 MAX OPER PRESS _____ PSIG OR _____ PSIA
 CORROSION ALLOW SHELL _____ IN DECK _____ IN

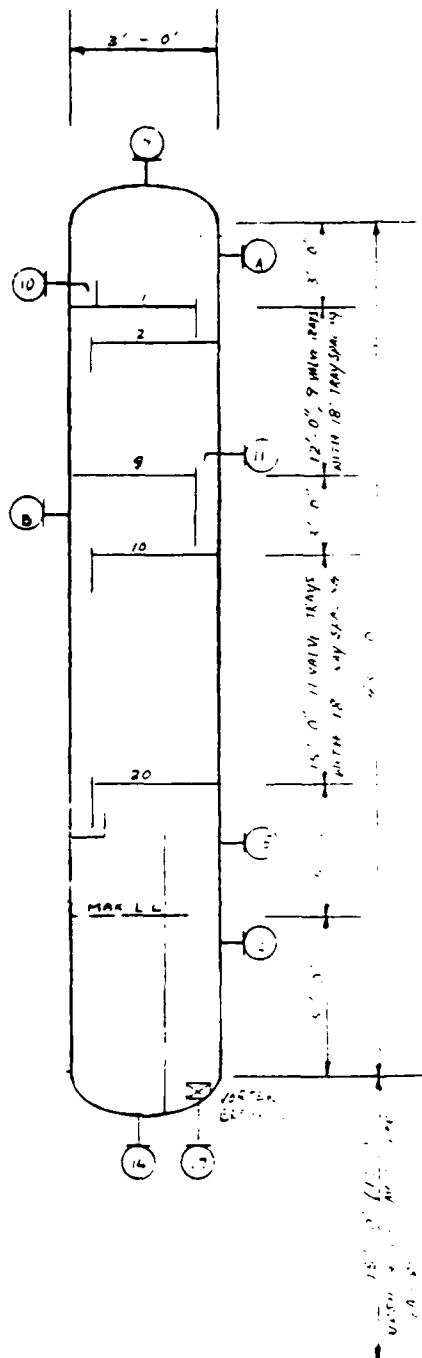
DES TEMP 250 °F
 DES PRESS _____ PSIG VAC _____ PSIA
 HEADS E.L.P. _____ DISHED X CONE _____ FLAT _____
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ IN
 INSULATION CONSERVN X PROTECTN _____ NONE _____
 DECK MATL CS W/VAL 250

NOZZLES FLG CLASS _____ COUPL CLASS _____

ITEM NO	SIZE	SERVICE & SYMBOL
1	2"	MANHOLE
2	2"	MANHOLE
3		
4		
5		HANDHOLE
6		
7	2"	VAPOR OUTLET TO <u>DA-255</u>
8		VENT
9		TO VACUUM EQUIPMENT
10	2"	REFLUX IN FROM <u>DA-256</u>
11	2"	FEED FROM <u>DA-25</u>
12		FEED FROM _____
13		FEED FROM _____
14	4"	TO REBOILER <u>DA-258</u>
15	2"	FROM REBOILER <u>DA-258</u>
16		EQUALIZING LINE WITH _____
17	2"	BOTTOM OUTLET TO <u>DA-257</u>
18		LIQUID OUTLET TO _____
19		DRAFF TO _____
20		RETURN FROM _____
21		DRAFF TO _____
22		RETURN FROM _____
23		DRAFF TO _____
24		RETURN FROM _____
25		REFLUX DRAFF TO _____
26		REFLUX IN FROM _____
27		REFLUX DRAFF TO _____
28		REFLUX IN FROM _____
29		PROCESS STEAM
30		STEAM OUT ISO
31		DRAIN
32		SAMPLE CONN IS. COOLER ISO
33		SAFETY VALVE (PSV)
34		SAFETY VALVE (PSV) (NSV)
35		UTILITY CONNECTION
36		PRESSURE GAGE (PG)
37		PRESSURE CONTROLLER (P) _____ C
38		PRESSURE TAPI (PT)
39		
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (T) _____ C
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44		
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49		
50		

FLANGED NOZZLES ARE
 NUMBERED 150
 FOR COUPLING ADD
 80 TO NOZZLE NO



NOTES: 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50.

		THE LUMMUS COMPANY						
		Birmingham						
TITLE <u>FEED PUMP PROJECT</u> CLIENT <u>AMOCO GULF STAR</u> LOCATION <u>BEULAH, MISSISSIPPI</u> PROJ NO <u>64-255</u> JOB NO <u>25571</u>								
PROCESS VESSEL SKETCH								
REV	DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR	VESSEL NO <u>DA-255</u>	DWG SKS -
1	11/11/64	FOR TALK 4						

VESSEL NO. DA-859 COME WITH _____
 VESSEL NAME DEHYDR COLUMN
 DIAMETER 2'-6" ID P-IN 8 P-OUT 8
 VERT HT 38'-4" P-IN BURY 15'-0" P-OUT 8
 HORIZ LENGTH _____
 OPER TEMP TOP 222° F BOT 612° F DRUM _____
 MAX TEMP TOP _____ BOT _____ DRUM _____
 NORM OPER PRESS 10 TAP HIG SS 13.80 TAP HIG _____
 MAX OPER PRESS _____ HIG OR _____
 CORROSION ALLOW SHELL _____ IN DECK _____ IN

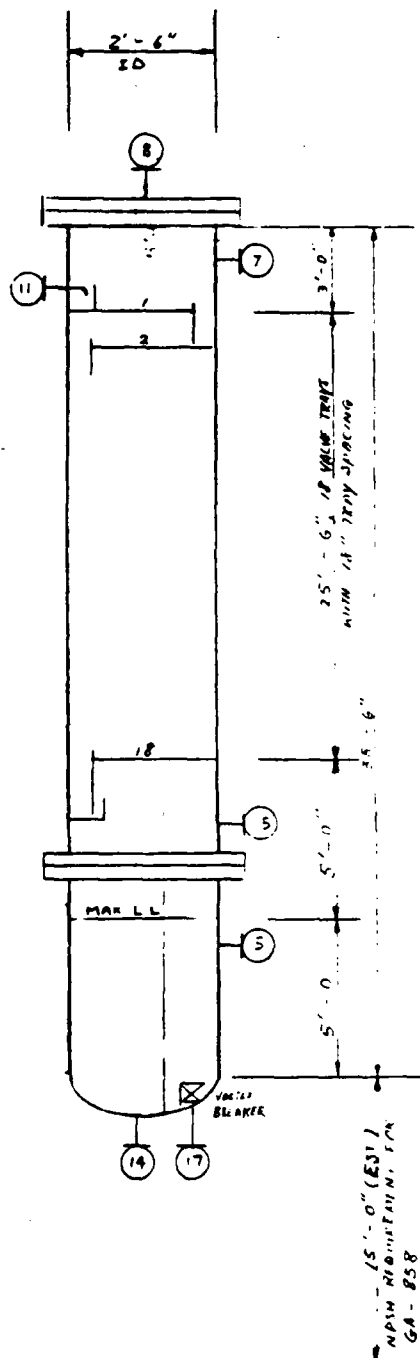
DES TEMP 460 °F
 DES PRESS 80 PSIG VAC _____ PSIG
 HEADS ELIP _____ DRUMED RA TYP CONE _____ FLAT TAP
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ MPH

MATL SHELL 304 SS LINER _____ THK _____ IN
 INSULATION CONSERVYN X PROTECTN _____ NONE _____
 DECK MATL 304 SS WELD 304 SS

NOZZLES FLG CLASS _____ COUPL CLASS _____

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1	REQD	IN	
1			MANHOLE
2			MANHOLE
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
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45			
46			
47			
48			
49			
50			

PLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 88 TO NOZZLE NO



NOTES L & SP 42 = 0.89 (AUG) @ OPERATING TEMP

		THE LUMMUS COMPANY	
		Houston	
TITLE <u>77 PNL PROJECT</u> CLIENT <u>AMER/DOE - GASTAR LOCATION BEULAH, ARK 72015-4</u> GASTAR PLANT PESH NO _____ DES NO <u>85571</u>			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	PESH DESIGNED PESH CHECKED APPROVED APPROVED
VESSEL NO <u>DA-859</u>		DESIGN NO _____	

ITEM NUMBER	SERVICE	MATERIAL	HEAT EXCHANGER MEDIUM				TEMPERATURE OF			OVERALL HEAT DUTY 1000 Btu/hr	TOTAL FACTORIAL CORRECTION	TOTAL SURFACE AREA	MAX ALLOWABLE PRESS DROP IN	PRESS. P.S.I.G.		SIZE AND TYPE	MATERIALS	
			FLOW RATE GPM	SPECIFIC GRAVITY	WATER VISCOSITY AT 100°F	WATER VISCOSITY AT 100°F	IN	OUT	DESIGN TEMP					OPERATING	DESIGN			NO UNITS AND OD BY LENGTH SYMBOLS
EA-251	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS
EA-252	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS
EA-253	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS
EA-254	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS
EA-255	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS
EA-256	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS
EA-257	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS
EA-258	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS
EA-259	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS
EA-260	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS
EA-261	HEATING CARBONATE	HP STEEL	9360	0.79	100	100	250	480	141	122	8660	0.001	6.5	10	6.5	11" x 11"	CS	CS

VESSEL NO. FA-PS1 COMB WITH _____
 VESSEL NAME FA-PS1
 DIAMETER 4'-0" ID IN-8 _____
 VERT HT _____ IN-8 _____
 NOZ LENGTH 12'-0" IN-8 _____
 OPER TEMP TOP _____ °F BOTY _____ °F DRUM 118 °F
 MAX TEMP TOP _____ °F BOTY _____ °F DRUM 167 °F
 NORM OPER PRESS _____ PSIG OR _____ PSIA
 MAX OPER PRESS _____ PSIG OR _____ PSIA
 CORROSION ALLOW SHELL _____ IN DECKS _____ IN

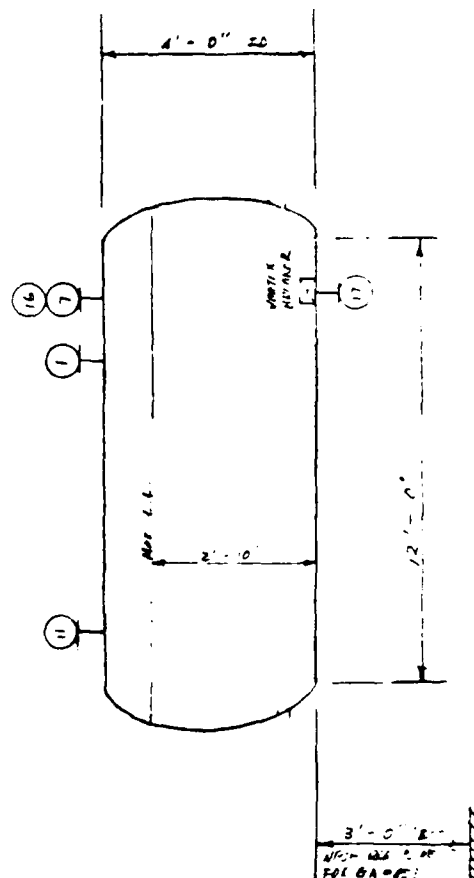
DES TEMP 235 °F
 DES PRESS 45 PSIG VAC _____ PSIA
 HEADS ELIP _____ DISHED X CONE _____ FLAT _____
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ HIGH

MATL SHELL CS LINER _____ THK _____ IN
 INSULATION CONSERVN X PROTECTN _____ NONE _____
 DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____

ITEM NO	SIZE	SERVICE & SYMBOL
1	12"	MANHOLE
2		MANHOLE
3		
4		
5		MANHOLE
6		
7	2"	VAPOR OUTLET TO <u>FLRCL</u>
8		VENT
9		TO VACUUM EQUIPMENT
10		REFLUX IN FROM
11	4"	FEED FROM <u>FA-RS2</u>
12		FEED FROM
13		FEED FROM
14		TO REBOILER (RES PUMP)
15		FROM REBOILER
16	2"	EQUALIZING LINE WITH <u>FA-RS2</u>
17	4"	BOTTOM OUTLET TO <u>GA-RS3</u>
18		LIQUID OUTLET TO
19		DRAFFOFF TO
20		RETURN FROM
21		DRAFFOFF TO
22		RETURN FROM
23		DRAFFOFF TO
24		RETURN FROM
25		REFLUX DRAFFOFF TO
26		REFLUX IN FROM
27		REFLUX DRAFFOFF TO
28		REFLUX IN FROM
29		PROCESS STEAM
30		STEAM OUT (SO)
31		DRAIN
32		SAMPLE CONN (S) COOLER (SC)
33		SAFETY VALVE (PSV)
34		SAFETY VALVE (PSV) (VSV)
35		UTILITY CONNECTION
36		PRESSURE GAGE (PG)
37		PRESSURE CONTROLLER (P) _____ C
38		PRESSURE TAP (PT)
39		
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (T) _____ C
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44		
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49		
50		

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 80 TO NOZZLE NO



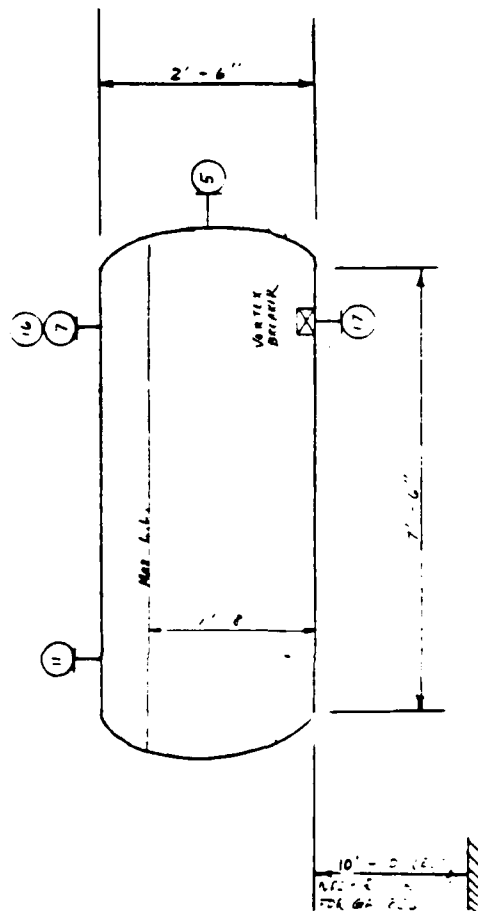
NOTES: 2.0 GPM OF GAS AT 0.64 G. Operation Temp


		THE LUMMUS COMPANY	
		Birmingham	
TITLE <u>JET FUEL PROJECT</u> CLIENT <u>ANDERSON</u> <u>ORCA</u> <u>PLANT</u> LOCATION <u>BEULAH, NEB</u> <u>2000</u> PROJ NO <u>06571</u>			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	PROJ. ENG.
1	11/14/71	FOR TANK 4	WJ
2			
3			
4			
5			
6			
7			
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11			
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46			
47			
48			
49			
50			

NOZZLES FLG CLASS _____ COUPL CLASS _____

ITEM NO	NO REGD	SIZE IN	SERVICE & SYMBOL
1			MANHOLE
2			MANHOLE
3			
4			
5		2	HANDHOLE
6			
7	1	1 1/2	VAPOR OUTLET TO FLARE
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11		2	FEED FROM GA-RSS
12			FEED FROM
13			FEED FROM
14			TO REBOILER (REB PUMP)
15			FROM REBOILER
16		1 1/2	EQUALIZING LINE WITH GA-RSS
17	2		BOTTOM OUTLET TO GA-RS
18			LIQUID OUTLET TO
19			DRAW-OFF TO
20			RETURN FROM
21			DRAW-OFF TO
22			RETURN FROM
23			DRAW-OFF TO
24			RETURN FROM
25			REFLUX DRAW-OFF TO
26			REFLUX IN FROM
27			REFLUX DRAW-OFF TO
28			REFLUX IN FROM
29			PROCESS STEAM
30			STEAM OUT (SO)
31			DRAIN
32			SAMPLE CONN (S) COOLER (CO)
33			SAFETY VALVE (SV)
34			SAFETY VALVE (SV) N2
35			UTILITY CONNECTION
36			PRESSURE GAGE (PG)
37			PRESSURE CONTROLLER P _____ C
38			PRESSURE (AP, PP)
39			
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER T _____ C
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

NOTES 430.6 Sp Gr = 0.76 @ 20° Temp



<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: center;">  </div> <div style="text-align: right;"> THE LUMBUS COMPANY Stamford </div> </div>									
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>TITLE <u>JET FUEL PROJECT</u></p> <p>CLIENT <u>AM/101 - GEN. DISLOCATION</u></p> <p>PROJECT <u>BEULAH N.E. - JAC'A</u></p> <p>PROJECT NO. <u>05571</u></p> </div> <div style="width: 50%; text-align: right;"> <p>PROJECT NO. <u>05571</u></p> </div> </div>									
PROCESS VESSEL SKETCH									
REV	ISSUE DATE	DESCRIPTION	PROL. SHEET	PROL. SHEET	APPR.	APPR.	VESSEL NO. <u>EA-252</u>		DWG. SKE. -

VESSEL NO. FA-853 COME WITH _____
 VESSEL NAME 25.04 COUPLER PUMP DRUM
 DIAMETER 5'-0" ID IN-SIDE _____
 VERT HT _____ IN-SIDE _____
 HORIZ LENGTH 15'-6" IN-SIDE _____
 OPER TEMP TOP _____ °F BOTT _____ °F DRUM 112 °F
 MAX TEMP TOP _____ °F BOTT _____ °F DRUM 265 °F
 NORM OPER PRESS _____ PSIG OR _____ PSIA
 MAX OPER PRESS _____ PSIG OR _____ PSIA
 CORROSION ALLOW SHELL _____ IN DECKS _____ IN

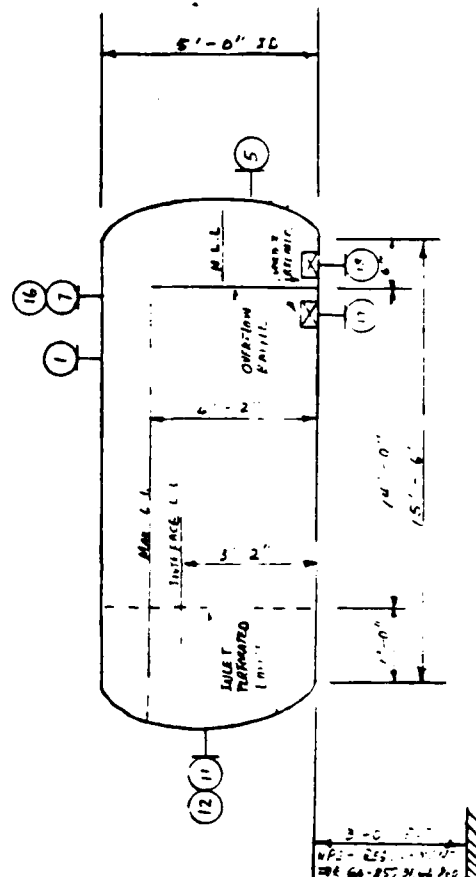
DES TEMP 265 °F
 DES PRESS 40 PSIG VAC _____ PSIA
 HEADS ELIP _____ DISHED _____ CONE _____ FLAT _____
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____

MATL SHELL CS LINER _____ THK _____ IN
 INSULATION CONSERV _____ PROTECTM _____ NONE
 DECK MATL _____

NOZZLES FLO CLASS _____ COUPL CLASS _____

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1	1	1/2"	MANHOLE
2	2	1/2"	MANHOLE
3	3	1/2"	MANHOLE
4	4	1/2"	MANHOLE
5	5	1/2"	MANHOLE
6	6	1/2"	MANHOLE
7	7	1/2"	MANHOLE
8	8	1/2"	MANHOLE
9	9	1/2"	MANHOLE
10	10	1/2"	MANHOLE
11	11	1/2"	MANHOLE
12	12	1/2"	MANHOLE
13	13	1/2"	MANHOLE
14	14	1/2"	MANHOLE
15	15	1/2"	MANHOLE
16	16	1/2"	MANHOLE
17	17	1/2"	MANHOLE
18	18	1/2"	MANHOLE
19	19	1/2"	MANHOLE
20	20	1/2"	MANHOLE
21	21	1/2"	MANHOLE
22	22	1/2"	MANHOLE
23	23	1/2"	MANHOLE
24	24	1/2"	MANHOLE
25	25	1/2"	MANHOLE
26	26	1/2"	MANHOLE
27	27	1/2"	MANHOLE
28	28	1/2"	MANHOLE
29	29	1/2"	MANHOLE
30	30	1/2"	MANHOLE
31	31	1/2"	MANHOLE
32	32	1/2"	MANHOLE
33	33	1/2"	MANHOLE
34	34	1/2"	MANHOLE
35	35	1/2"	MANHOLE
36	36	1/2"	MANHOLE
37	37	1/2"	MANHOLE
38	38	1/2"	MANHOLE
39	39	1/2"	MANHOLE
40	40	1/2"	MANHOLE
41	41	1/2"	MANHOLE
42	42	1/2"	MANHOLE
43	43	1/2"	MANHOLE
44	44	1/2"	MANHOLE
45	45	1/2"	MANHOLE
46	46	1/2"	MANHOLE
47	47	1/2"	MANHOLE
48	48	1/2"	MANHOLE
49	49	1/2"	MANHOLE
50	50	1/2"	MANHOLE

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO



NOTES: 1.0000 SP GR = 1.01 (AVE); @ Operating Temp

		THE LUMBUS COMPANY Birmingham	
TITLE <u>JET FUEL PROJECT</u> CLIENT <u>ANDERSON-CHETTING</u> LOCATION <u>BEULAH, NORTH CAROLINA</u> PROJ NO _____ DES NO <u>06571</u>			
PROCESS VESSEL SKETCH			
REV _____ DATE _____		VESSEL NO <u>FA-853</u>	

REV	DATE	DESCRIPTION	PROJ	DES	APP	APP
1	11/10/71	FOR TALK 4				

VESSEL NO. FA-254 COMB WITH _____
 VESSEL NAME MT-211-1-2-12-12-12
 DIAMETER 3'-6" R-10 8 R-10
 VERT HT 10'-6" R-10 SHIRT R-10
 HORIZ LENGTH 10'-6" R-10
 OPER TEMP TOP _____ ° F BOTT _____ ° F DRUM 150 ° F
 MAX TEMP TOP _____ ° F BOTT _____ ° F DRUM 171 ° F
 NORM OPER PRESS 7.0 PSIG OR _____ PSIG
 MAX OPER PRESS _____ PSIG OR _____ PSIG
 CORROSION ALLOW SHELL _____ IN DECK _____ IN

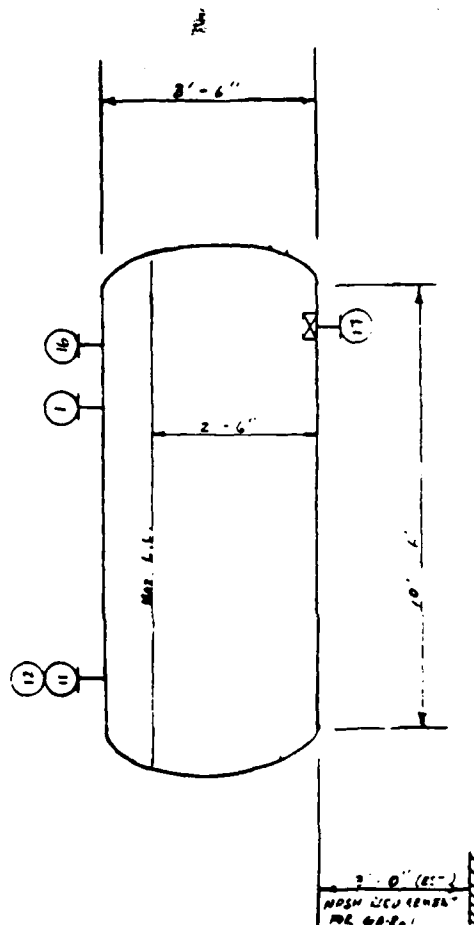
DES TEMP 230 ° F
 DES PRESS 7.0 PSIG VAC _____ PSIG
 HEADS ELP _____ DISHED _____ CONE _____ FLAT _____
 CODE ASME _____ AM _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____

MATL SHELL CS LINER _____ THK _____ IN
 INSULATION CONSERV _____ PROTECTIN _____ NONE
 DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1	1	1/2	MANHOLE
2	2	1/2	MANHOLE
3	3	1/2	MANHOLE
4	4	1/2	MANHOLE
5	5	1/2	MANHOLE
6	6	1/2	MANHOLE
7	7	1/2	MANHOLE
8	8	1/2	MANHOLE
9	9	1/2	MANHOLE
10	10	1/2	MANHOLE
11	11	1/2	MANHOLE
12	12	1/2	MANHOLE
13	13	1/2	MANHOLE
14	14	1/2	MANHOLE
15	15	1/2	MANHOLE
16	16	1/2	MANHOLE
17	17	1/2	MANHOLE
18	18	1/2	MANHOLE
19	19	1/2	MANHOLE
20	20	1/2	MANHOLE
21	21	1/2	MANHOLE
22	22	1/2	MANHOLE
23	23	1/2	MANHOLE
24	24	1/2	MANHOLE
25	25	1/2	MANHOLE
26	26	1/2	MANHOLE
27	27	1/2	MANHOLE
28	28	1/2	MANHOLE
29	29	1/2	MANHOLE
30	30	1/2	MANHOLE
31	31	1/2	MANHOLE
32	32	1/2	MANHOLE
33	33	1/2	MANHOLE
34	34	1/2	MANHOLE
35	35	1/2	MANHOLE
36	36	1/2	MANHOLE
37	37	1/2	MANHOLE
38	38	1/2	MANHOLE
39	39	1/2	MANHOLE
40	40	1/2	MANHOLE
41	41	1/2	MANHOLE
42	42	1/2	MANHOLE
43	43	1/2	MANHOLE
44	44	1/2	MANHOLE
45	45	1/2	MANHOLE
46	46	1/2	MANHOLE
47	47	1/2	MANHOLE
48	48	1/2	MANHOLE
49	49	1/2	MANHOLE
50	50	1/2	MANHOLE

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO



NOTES: Liquid Sp Gr = 0.816 @ Operating Temp

		THE LUMBER COMPANY	
		Beverly Hills	
TITLE <u>J77 Fuel Project</u> CLIENT <u>Amoco Gulf Ref</u> LOCATION <u>Beverly Hills, North 210°</u> DES. F. PLANT _____ DES. NO. <u>DES 71</u>			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	DESIGN
1	11/11/71	FOR TRK 4	
VESSEL NO. <u>FA-254</u>		SWS NO. _____	

VESSEL NO FA-851 COMB WITH _____
 VESSEL NAME MANHOLE STOP-46 TANK
 DIAMETER 10'-0" R-IN 8
 VERT HT 16'-0" R-IN BLURT _____
 HORIZ LENGTH _____ R-IN _____
 OPER TEMP TOP 7 BOTY 7 DRUM 2-2
 MAX TEMP TOP 7 BOTY 7 DRUM 7
 NORM OPER PRESS _____ PSIG OR _____
 MAX OPER PRESS 6" B.O. PSIG OR _____
 CORROSION ALLOW SHELL IN DECK _____ IN

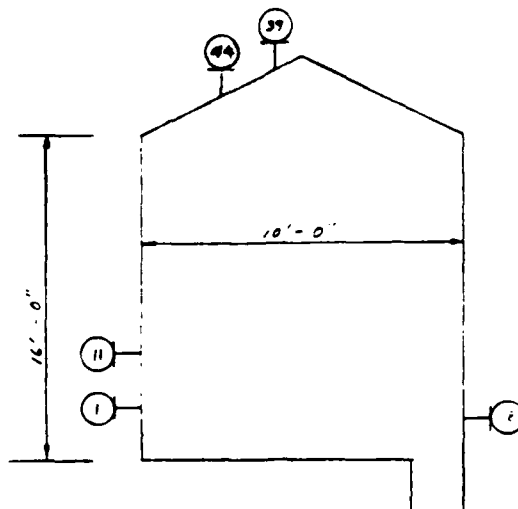
DES TEMP 230 °
 DES PRESS 8" H.C. VAC -2" H.G.
 HEADS ELIP _____ DISHED _____ CONE 20° FLAT 20°
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____

MATL SHELL _____ LINER _____ THK _____ IN
 INSULATION CONSERV _____ PROTECTN _____ NONE
 DECK MATL _____

NOZZLES FLO CLASS _____ COUPL CLASS _____

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1	1	24	MANHOLE (24")
2			MANHOLE
3			
4			
5			MANHOLE
6			
7			VAPOR OUTLET TO _____
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM _____
11	3		FEED FROM <u>24" TAIL</u>
12			FEED FROM _____
13			FEED FROM _____
14			TO REBOILER (RES PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH _____
17			BOTTOM OUTLET TO _____
18			LIQUID OUTLET TO <u>24" TAIL</u>
19			DRAFF TO _____
20			RETURN FROM _____
21			DRAFF TO _____
22			RETURN FROM _____
23			DRAFF TO _____
24			RETURN FROM _____
25			REFLUX DRAFF TO _____
26			REFLUX IN FROM _____
27			REFLUX DRAFF TO _____
28			REFLUX IN FROM _____
29			PROCESS STEAM
30			STEAM OUT (SO)
31			DRAIN
32			SAMPLE CONN (SI) COOLER (CO)
33			SAFETY VALVE (SV)
34			SAFETY VALVE (PSV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PG)
37			PRESSURE CONTROLLER (P) _____
38			PRESSURE TAP (PT)
39	1	1/2	<u>24" TAIL</u>
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (TC) _____
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44	1	4	<u>24" TAIL</u>
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO



NOTES: 1. 24" TAIL = 0.66 @ 10" TO-P

		THE LUMMUS COMPANY Houston	
		TITLE <u>J-1 FUEL PROJECT</u> CLIENT <u>ARCO/DOE - GULF COASTAL BEULAH, NORTH DAKOTA</u> PROJ NO <u>05571</u>	
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	PROJ. NO.
1	4/11/79	FOR TASK 4	05571
VESSEL NO <u>FA-851</u>		SHEET NO. <u>1</u>	

VESSEL NO. FB-852 COMB WITH _____
 VESSEL NAME CRUDE CRACKER A.D. DAY TANK
 DIAMETER 12'-0" TALL 8 R-44
 VERT HT. 12'-0" R-44 SKIRT _____ R-44
 WORK LENGTH _____ R-44
 OPER TEMP TOP _____ ° BOTTL _____ ° DRUM ANA °
 MAX TEMP TOP _____ ° BOTTL _____ ° DRUM 112 °
 WORK OPER PRESS _____ PSI OR _____
 MAX OPER PRESS 6 PSI OR _____
 CORROSION ALLOW SHELL _____ IN DECK _____ IN

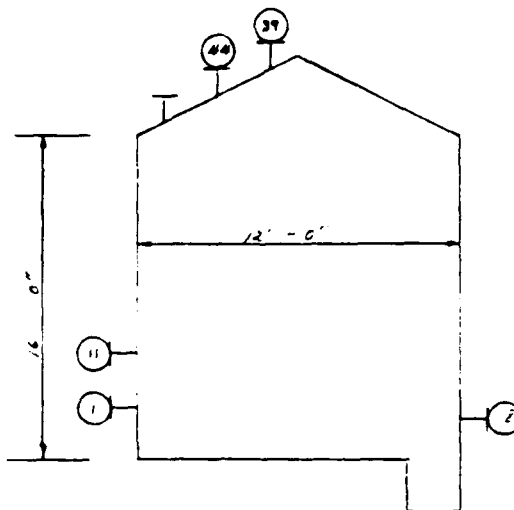
DES TEMP 250 °
 DES PRESS 2 PSI VAC -2 PSI
 HEADS ELIP _____ DISHD _____ CONE FLAT FLAT 2'-0"
 CODE ARME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____

MATL SHELL CS LINER _____ THK _____ IN
 INSULATION CONSERVYN X PROTECTN _____ NONE
 DECK MATL _____

NOZZLES FLO CLASS _____ COUPL. CLASS _____

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1			MANHOLE (SHELL)
2			MANHOLE
3			
4			MANHOLE
5			
6			VAPOR OUTLET TO _____
7			VENT
8			TO VACUUM EQUIPMENT
9			REFLUX IN FROM _____
10			FEED FROM <u>2'-0"</u>
11			FEED FROM _____
12			FEED FROM _____
13			FEED FROM _____
14			TO (REBOILER, REB PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH _____
17			BOTTOM OUTLET TO _____
18			LIQUID OUTLET TO <u>2'-0"</u>
19			DRAWOFF TO _____
20			RETURN FROM _____
21			DRAWOFF TO _____
22			RETURN FROM _____
23			DRAWOFF TO _____
24			RETURN FROM _____
25			REFLUX DRAWOFF TO _____
26			REFLUX IN FROM _____
27			REFLUX DRAWOFF TO _____
28			REFLUX IN FROM _____
29			PROCESS STEAM
30			STEAM OUT. SO _____
31			DRAIN
32			SAMPLE CONN. (S) COOLER (CO)
33			SAFETY VALVE (SV)
34			SAFETY VALVE (SV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PG)
37			PRESSURE CONTROLLER (P) _____
38			PRESSURE TAP (PT)
39			<u>2'-0"</u>
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T) _____
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			<u>2'-0"</u>
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO

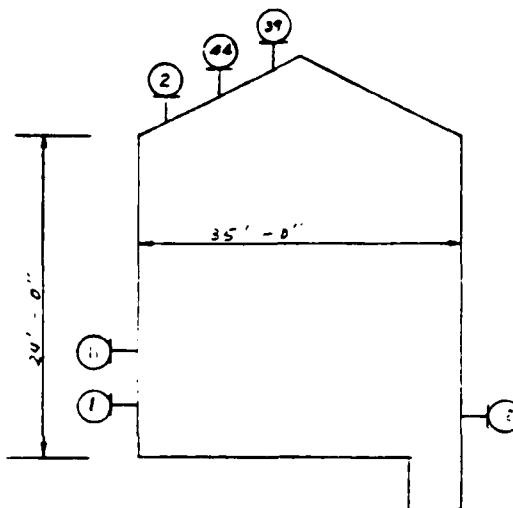


NOTES LC - 4 6 - 1 - 02 @ Spouting Temp


		THE LUMMUS COMPANY	
		Houston, Texas	
TITLE <u>JET FUEL PROJECT</u> CLIENT <u>AMOCO</u> PROJECT LOCATION <u>BEPLAN, NORTH BRITAIN</u> PROJECT NO. <u>05571</u>			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	DESIGN
1	10/10/50	FOR TASK 4	N1
VESSEL NO. <u>FB-852</u>		SHEET NO. <u>1</u>	

NOZZLE: 05 PUG CLASS: _____ COUPL CLASS: _____

FLANGED NOZZLES ARE
NUMBERED 1-50
FOR COUPLING ADD
50 TO NOZZLE NO



NOTES L.A. & G. = 10: @ Springing Temp

		THE LUMMUS COMPANY Houston, Texas	
TITLE <u>JET FUEL PROJECT</u>			
CLIENT <u>AMOCO-GULF COASTAL</u>		LOCATION <u>BEULAH, NORTH DAKOTA</u>	
PROJECT <u>NO. 0571</u>		JOB NO. <u>0571</u>	
PROCESS VESSEL SKETCH			
VESSEL NO. <u>FA-852 A & B</u>		SHEET NO. <u>-</u>	

AREA 900

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571

DATE/BY: 21-Mar-89
09:16 AM

EQUIPMENT # PCS. \$ EQUIP. % COMM \$ COMM

<u>HEATERS</u>				
<u>TOWERS</u>	5	\$453	100%	\$453
<u>INTERNALS</u>		\$218		
<u>REACTORS</u>				
<u>EXCHANGERS</u>	16	\$220	110%	\$242
<u>VESSELS</u>	4	\$19	120%	\$23
<u>TANKS</u>	6	\$69	80%	\$55
<u>FILTERS</u>				
<u>PUMPS</u>	28	\$210	110%	\$231
<u>COMPRESSORS</u>	2	\$50	110%	\$55
<u>PACKAGE UNITS</u>				
<u>TOTAL</u>	61	\$1,239		\$1,059

SUMMARY

<u>EQUIPMENT</u>	\$1,239
<u>COMMODITIES</u>	\$1,059
<u>LABOR</u>	\$759 (10% EQUIP, 60% COMM)
<u>INDIRECTS</u>	\$759 (100% LABOR)
<u>ENGINEERING</u>	<u>\$2,440</u> (800/PC X \$50)
<u>SUBTOTAL</u>	\$6,257
<u>CONTINGENCY</u>	<u>\$1,251</u> (20%)
<u>TOTAL</u>	\$7,508

EQUIPMENT SUMMARY

	<u>WEIGHT</u>	<u>MATL</u>	<u>\$/LB</u>	<u>\$</u>
DA-901 PHENOL/ORTHO COL	100000	CS	\$1.40	\$140,000
DA-902 PHENOL COL	35000	CS	\$1.60	\$56,000
DA-902B PHENOL COL	35000	CS	\$1.60	\$56,000
DA-903 M,P-CRESOL COL.	86000	CS	\$1.50	\$129,000
DA-904 XYLENOL TOPPING COL.	45000	CS	\$1.60	\$72,000
			TOTAL	\$453,000

	<u>FT2</u>	<u>MATL</u>	<u>\$/FT2</u>	<u>\$</u>
DB-901 PHENOL/ORTHO COL	4800	CS/SS VALVES	\$18.00	\$86,400
DB-902 PHENOL COL	900	CS/SS VALVES	\$18.00	\$16,200
DB-902B PHENOL COL	1000	CS/SS VALVES	\$18.00	\$18,000
DB-903 M,P-CRESOL COL.	3500	CS/SS VALVES	\$18.00	\$63,000
DB-904 XYLENOL TOPPING COL.	1900	CS/SS VALVES	\$18.00	\$34,200
			TOTAL	\$217,800

DOE JET FUEL

EQUIPMENT SUMMARY

	<u>FT2</u>	<u>MATL</u>	<u>\$/FT2</u>	<u>\$</u>
EA-901 PHENOL/ORTHO COL. REBOIL	790	CS/CS	\$27.00	\$21,330
EA-902 PHENOL/ORTHO COL. COND	522	CS/CS	\$19.00	\$9,918
EA-903 PHENOL COL. REBOIL	300	CS/18-2	\$95.00	\$28,500
EA-904 PHENOL COL COND	286	CS/CS	\$28.00	\$8,008
EA-905 M,P-CRESOL COL. REBOIL	750	CS/18-2	\$28.00	\$21,000
EA-906 M,P-CRESOL COL. COND	520	SS/SS	\$60.00	\$31,200
EA-907 XYLENOL TOPPING COL REBOIL	374	CS/18-2	\$90.00	\$33,660
EA-908 XYLENOL TOPPING COL COND	236	SS/SS	\$120.00	\$28,320
EA-909 PHENOL/ORTHO COL. INTER	51	CS/CS	\$100.00	\$5,100
EA-910 PHENOL COL. BTMS. COOL	68	CS/CS	\$90.00	\$6,120
EA-911 XYLENOL TOPPING COL. BTMS	35	CS/CS	\$125.00	\$4,375
EA-912 M,P-CRESOL PRODUCT COOLER	135	CS/CS	\$50.00	\$6,750
EA-913 O-CRESOL TOPPING CGL OH.	16	CS/CS	\$200.00	\$3,200
EA-914 O-CRESOL PRODUCT COOL.	46	CS/CS	\$110.00	\$5,060
EA-915 XYLENOL COL. INTER.	18	CS/CS	\$200.00	\$3,600
EA-916 2,4/2,5 XYLENOL PROD. COOL	22	CS/CS	\$200.00	\$4,400
			TOTAL	\$220,541

DOE JET FUEL

EQUIPMENT SUMMARY

FA-901 PHENOL/ORTHO REFLUX DRUM
 FA-902 PHENOL REFLUX DRUM
 FA-903 M/P-CRESOL REFLUX DRUM
 FA-904 XYLENOL TOPPING REFLUX

<u>WEIGHT</u>	<u>MATL</u>	<u>\$/LB</u>	<u>\$</u>
2000	CS	\$2.75	\$5,500
1000	CS	\$4.00	\$4,000
2000	CS	\$2.75	\$5,500
1000	CS	\$4.00	\$4,000
TOTAL			\$19,000

DOE JET FUEL

FB-901 O-CRESOL TOP. FEED DAY TANK
FB-902 XYLENOLS INT. DAY TANK
FB-903 O-CRESOL DAY TANK
FB-905 M, P-CRESOL DAY TANK
FB-906 2,4/2,5-XYLENOL DAY TANK
FB-907 MIXED XYLENOLS DAY TANK

F-160


EQUIPMEN. SUMMARY

GA-901&S	PHENOL/ORTHO BTMS	<10HP	CS	\$15,000
GA-902&S	PHENOL/ORTHO REFLUX	<10HP	CS	\$15,000
GA-903&S	PHENOL BTMS	<10HP	CS	\$15,000
GA-904&S	PHENOL REFLUX	<10HP	CS	\$15,000
GA-905&S	M,P CRESOL BTMS	<10HP	CS	\$15,000
GA-906&S	M,P CRESOL REFLUX	<10HP	CS	\$15,000
GA-908	O-CRESOL TOPPING	<10HP	CS	\$7,500
GA-909	MIXED XYLENOL	<10HP	CS	\$7,500
GA-910	2,4/2,5-XYLENOL	<10HP	CS	\$7,500
GA-911	M,P-CRESOL	<10HP	CS	\$7,500
GA-912	XYLENOLS	<10HP	CS	\$7,500
GA-913	O-CRESOL	<10HP	CS	\$7,500
GA-914&S	PHENOL COL. INTERM.	<10HP	CS	\$15,000
GA-915&S	XYLENOL TOPPING	<10HP	CS	\$15,000
GA-916&S	XYLENOL TOPPING REFLUX	<10HP	CS	\$15,000
GA-917&S	O-CRESOL TOP. COL. FEED	<10HP	CS	\$15,000
GA-918&S	XYLENOL COL. FEED	<10HP	CS	<u>\$15,000</u>
TOTAL				\$210,000
GB-901,S VACUUM PUMP				
TOTAL				\$50,000

DOE JET FUEL

SESS TEMP 405 °
 DEEP PRESS 45
 HELDS ELP DISHED ✓ VAC FULL PLAT _____
 CODE ASME VIII API _____ OTHER _____
 STRESS RELIEVED YES ✓ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____
 MATL. SPEC. CS LOWER _____ THE _____
 INSULATION CONSERVATION ✓ PROTECTN _____ HOME _____
 DECK MATL. CS VALVE MATL. 304 SS
 NOZZLES PLUG CLASS 150 COUPL. CLASS _____

ITEM NO.	SIZE	SERVICE & SYMBOL
1	24	MANHOLE
2		MANHOLE
3		
4		HANDHOLE
5		
6	18	VAPOR OUTLET TO EA-902
7		VENT
8		TO VACUUM EQUIPMENT
9	5	REFLUX IN FROM FA-901
10	1 1/2	REFLUX FROM GA-853 & GA-977
11		REFLUX FROM
12		REFLUX FROM
13		REFLUX FROM
14	8	TO REBOILER (REFLUX) EA-901
15	1 1/2	FROM REBOILER EA-901
16		EQUALIZING LINE WITH
17	1 1/2	BOTTOM OUTLET TO GA-901
18		LIQUID OUTLET TO
19		DRAWOFF TO
20		RETURN FROM
21		DRAWOFF TO
22		RETURN FROM
23		DRAWOFF TO
24		RETURN FROM
25		REFLUX DRAWOFF TO
26		REFLUX IN FROM
27		REFLUX DRAWOFF TO
28		REFLUX IN FROM
29		PROCESS STEAM
30		STEAM OUT SCI
31		DRAIN
32		SAMPLE CONT. CO. 110
33		SAFETY VALVE
34		SAFETY VALVE (PSV) VS 1
35		UTILITY CONNECTION
36		PRESSURE SAGE (PG)
37		PRESSURE CONTROLLER (P) _____
38		PRESSURE TAP (PT)
39		
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (T) _____
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44		
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47	1	INTERNAL LEVEL
48		LEVEL ALARM (LA)
49		
50		

 <p>THE LUMMUS COMPANY Baltimore</p>	<p>THE LUMMUS COMPANY Baltimore</p>
<p>WILL JET FUEL PROJECT ELECTRICITY/AT-SPATIALIZATION REVIAM, NORTH BAY PLASMA GASES RANT FROM NO 200 AND NO 06571</p>	
<p>PROCESS VESSEL SKETCH</p>	
<p>VESSEL NO DA-901</p>	<p>DRG NO -</p>

CE LUM VALVE TRAY COMPUTER PROGRAM 4-9-79 DATE 13 APR 75 1046
 BY SUNIL USED AT 10-11-07 IN H/11/11. 1744JJS JOR OR ESTIMATE 5571
 COLUM 901-CARBONIC ACID RECOVERY DEPT 302 OFFICE LTD

LAYOUT DIMENSIONS

TRAY SPACING, INCHES
 TYPE OF FLUM

DESIGN BOARD VAPOR RATE VAPOR DENSITY LIQUID RATE LIQUID DENSITY SURFACE TENSION LIQUID VISCOSITY
 LBS/HR LBS/FT³ LBS/HR LBS/FT³ DYNE/CM CENTIPOISE

MAXIMUM = 33262.03 0.0910 10284.00 60.00000 27.37 36900
 MINIMUM = 30100.00 0.13300 15213.50 54.20000 19.30 27200

DOWNCOMER LOCATION 1-SIDE
 DOWNCOMER TYPE 2-SLOPING
 DOWNCOMER PLATE TO SHELL DISTANCE 8-503
 DOWNCOMER PLATE TO SHELL DISTANCE 9-503
 DOWNCOMER PLATE TO SHELL DISTANCE 1-203
 DOWNCOMER PLATE TO SHELL DISTANCE 1-503

DOWNCOMER PLATE TO SHELL DISTANCE 50-666
 DOWNCOMER PLATE TO SHELL DISTANCE 90-666
 DOWNCOMER PLATE TO SHELL DISTANCE 50-666
 DOWNCOMER PLATE TO SHELL DISTANCE 90-666

DOWNCOMER PLATE TO SHELL DISTANCE 50-666
 DOWNCOMER PLATE TO SHELL DISTANCE 90-666
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 DOWNCOMER PLATE TO SHELL DISTANCE 90-666

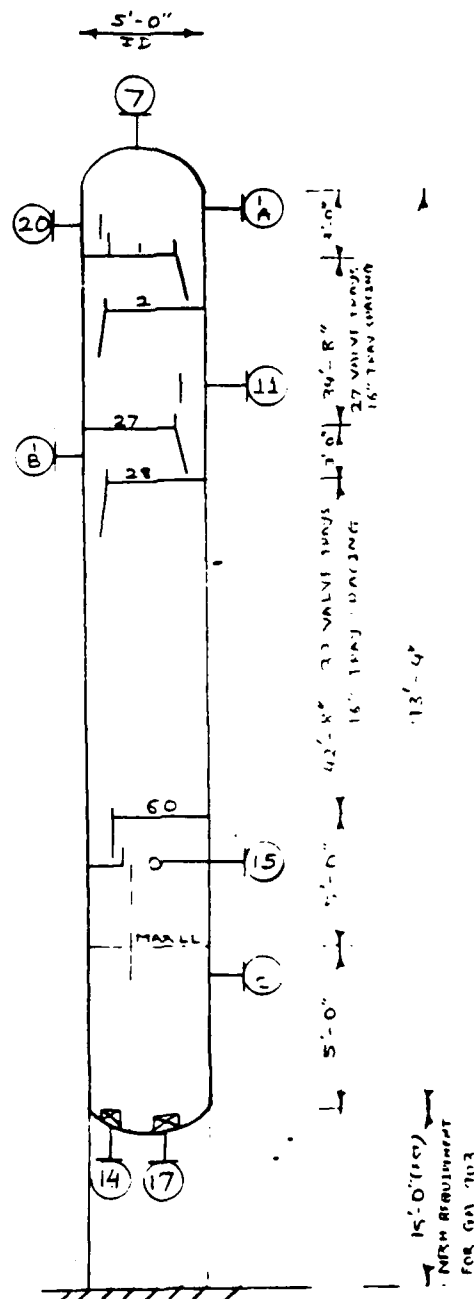
DOWNCOMER PLATE TO SHELL DISTANCE 50-666
 DOWNCOMER PLATE TO SHELL DISTANCE 90-666
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 DOWNCOMER PLATE TO SHELL DISTANCE 90-666
 DOWNCOMER PLATE TO SHELL DISTANCE 50-666
 DOWNCOMER PLATE TO SHELL DISTANCE 90-666

NOTE: 1) DA-902 consists of 2 shells (DA-902A & B)
At the time of design a single shell configuration will be investigated.



		M-14 TS	FOL TANK 4	JL						
REV	DATE	DESCRIPTION	PREL	PREL	APPR	APPR	DESIGN NO.	DA-902A	DWG. NO.	

VESSEL NO. DA-902-B COMB WITH _____
 VESSEL NAME HEAT EXCHANGER / STEEL COLUMN (Atmosphere Service)
 DIAMETER 5'-0" NO. 1 15'-0" NO. 2
 VERT HT 52'-4" NO. 1 15'-0" NO. 2
 HORIZ LENGTH 25'-4" NO. 1 31'-2" NO. 2
 OPER TEMP: TOP 254 °F BOT 312 °F STEAM _____ °F
 MAX TEMP: TOP _____ °F BOT _____ °F STEAM _____ °F
 NORM OPER PRESS -12.5 PSIA NO. 2 -8.1 PSIA NO. 3
 MAX OPER PRESS _____ PSIA NO. 2 _____ PSIA NO. 3
 CORROSION ALLOW: SHELL 3 IN. NO. 2 _____ IN. NO. 3

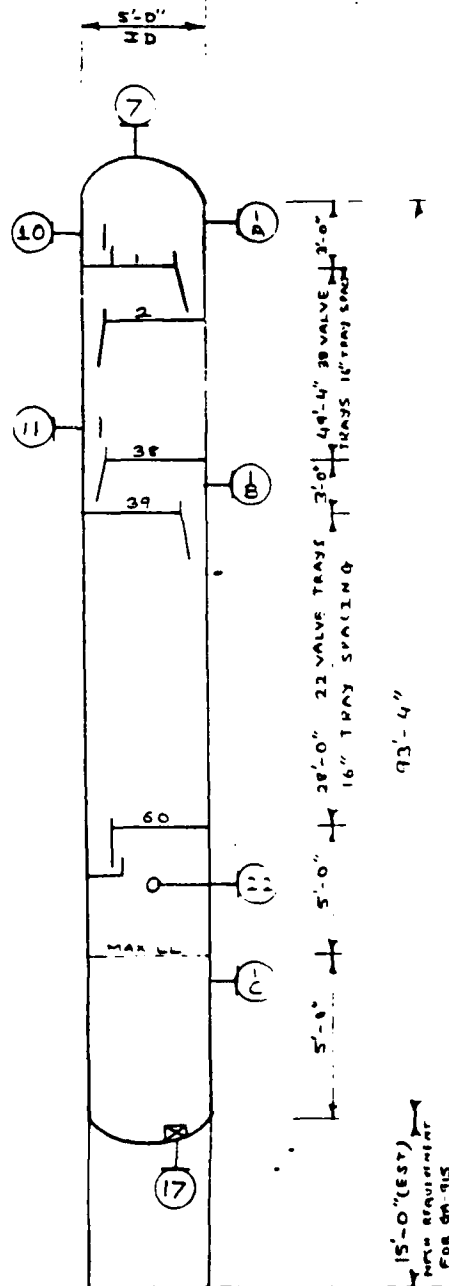
DES TEMP 340 °F
 DES PRESS 45 PSIA VAC _____ PSIA
 HEAD: SLIP _____ DESIGD _____ CONE _____ PLAT _____
 CODE: ASME _____ API _____ OTHER _____
 STRESS RELIEVED: YES _____ CODE _____
 RADIOGRAPHED: YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ SEA _____

MATL: SHELL C.S. LINER _____ TUB _____ IN _____
 INSULATION: CONSERV _____ PROTECTN _____ NONE _____
 DECK MATL: C.S. WALKS MATL 304SS

NOZZLES: FLS CLASS _____ COUP CLASS _____

ITEM NO	SIZE	SERVICE & SYMBOL
1	24	MANHOLE
2		MANHOLE
3		
4		
5		MANHOLE
6		
7	10	VAPOR OUTLET TO <u>EA-904</u>
8		VENT
9		TO VACUUM EQUIPMENT
10	1/2	REFLUX IN FROM <u>EA-902</u>
11	1/2	FEED FROM <u>GA-901</u>
12		FEED FROM _____
13		FEED FROM _____
14		TO REBOILER (HEAT PUMP)
15		FROM REBOILER
16		EQUALIZING LINE WITH _____
17		BOTTOM OUTLET TO <u>GA-901</u>
18		LIQUID OUTLET TO _____
19		DRAWOFF TO _____
20		RETURN FROM _____
21		DRAWOFF TO _____
22	1	RETURN FROM <u>DA-902-A</u>
23		DRAWOFF TO _____
24		RETURN FROM _____
25		REFLUX DRAWOFF TO _____
26		REFLUX IN FROM _____
27		REFLUX DRAWOFF TO _____
28		REFLUX IN FROM _____
29		PROCESS STEAM
30		STEAM OUT (CO)
31		DRAIN
32		SAMPLE CONN. RE COOLER (CO)
33		SAFETY VALVE (PSV)
34		SAFETY VALVE (PSV) (NEW)
35		UTILITY CONNECTION
36		PRESSURE GAUGE (PG)
37		PRESSURE CONTROLLER (P) _____ D
38		PRESSURE TAP (PT)
39		
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (T) _____ D
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44		
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49		
50		

FLANGED NOZZLES ARE
 NUMBERED 1-10
 FOR COUPLING ADD
 50 TO NOZZLE NO.



NOTE: LIQ SP GR = 0.97 (avg) @ operating temp

		THE LUMMUS COMPANY	
		Birmingham	
TITLE JET FUEL PROTECT CLIENT AND/OR DESIG. ORGANIZATION SEULAH, NORTH DAKOTA PROJECT NO. 05671			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	DESIGNED BY
1	11/1/57	FOR TAIL 4	11/1/57
VESSEL NO. DA-902-B		DWS DES -	

CE LUMUS VALVE TRAY COMPUTER PROGRAM 4-9214 RELEASE 03 DATE 0 APR 25 1986 BATCH LUMHJS JUR UR ESTIMATE 5571
 BY SUNIL USED AT 12:49:00 ON 09/11/11. DESIGN - FIND ROUNDED TO SXF DEPT 302 OFFICE LTD
 COLUMN 902 CRESYLIC ACID RECOVERY

LAYOUT DIMENSIONS

TRAY SPACING, INCHES 15.000 INSIDE TOWER DIAMETER, INCHES 60.00
 TYPE OF FLOW SXF (1-PASS)

DESIGN LOADS VAPOR RATE VAPOR DENSITY LIQUID RATE LIQUID DENSITY SURFACE TENSION LIQUID VISCOSITY
 LBS/HR LBS/FT³ LBS/FT³ LBS/HR LBS/FT³ DYNES/CM CENTIPOISE
 MAXIMUM = 15450.00 0.02740 14200.00 61.10000 27.95 36900
 BASED ON OVERDESIGN TO 100.0 O/D OF VAPOR AND TO 100.0 O/D OF LIQUID MINIMAL RATES FOR MAXIMUM LOADED TRAY
 MINIMUM = 15172.50 0.13500 17104.50 56.55000 71.48 27400
 BASED ON TURNDOWN TO 70.0 O/D OF VAPOR AND TO 70.0 O/D OF LIQUID MINIMAL RATES FOR MINIMUM LOADED TRAY

DOWNCOMER LOCATION 1= SIDE
 DOWNCOMER TYPE 2= SLOPING
 * INLET WEIR

DIMENSIONS AT TOP OF DOWNCOMER, INCHES

DOWNCOMER WIDTH (NOTE 1) 6.000
 DOWNCOMER PLATE TO SHELL DISTANCE 6.000
 OUTLET WEIR HEIGHT 1.250
 WEIGHT OF OUTLET WEIR NOTCH 1.500
 OUTLET WEIR LENGTH (NOTE 2) 36.000
 C-WORD LENGTH AT DOWNCOMER PLATE (NOTE 2) 36.000

DIMENSIONS AT BOTTOM OF DOWNCOMER, INCHES

DOWNCOMER WIDTH (NOTE 1) 4.250
 DOWNCOMER CLEARANCE (NOTE 3) 0.750
 DOWNCOMER BOTTOM TO TRAY INLET (NOTE 4) 1.750
 INLET WEIR HEIGHT 1.250
 INLET WEIR LENGTH (NOTE 2) 36.000
 DOWNCOMER PLATE TO SHELL DISTANCE (NOTE 2) 4.250
 LENGTH OF DOWNCOMER PLATE (NOTE 2) 30.785
 INLET WEIR TO SHELL DISTANCE 6.000
 C-WORD LENGTH AT INLET WEIR (NOTE 2) 36.000

NOTE 1 - PER DOWNCOMER, NOTE 2 - PER DOWNCOMER PLATE, NOTE 3 - DIMENSION ABOVE TRAY FLOOR, NOTE 4 - HORIZONTAL DISTANCE

NOTE 5 - * INDICATES SPECIAL TRAY FEATURE

***** ATTACH THIS SHEET TO THE VALVE TRAY DATA SHEET TO MAKE A PROCESS SPECIFICATION FOR THIS TRAY *****

VESSEL NO. DA-903 COMB WITH
 VESSEL NAME H.P. CRYSTAL COLUMN
 DIAMETER 7'-6" DIA. 6
 VERT. HT. 13'-6" DIA. 15'-0"
 NOZZLE LENGTH
 OPER. TEMP. TOP 287 °F BOTT. 370 °F DRUM
 MAX. TEMP. TOP 287 °F BOTT. 370 °F DRUM
 NORM. OPER. PRESS. -2.8 PSIG OR -6.7 (VACUUM) PSIG
 MAX. OPER. PRESS. -2.8 PSIG OR -6.7 (VACUUM) PSIG
 CORROSION ALLOW. SHLL 3 IN. DIA. DECK

DES. TEMP. 395 °F
 DES. PRESS. LS PSIG VAC. FULL PSIG
 HEADS: SLIP ✓ DRUMED ✓ CONF. ✓ FLAT
 CODE ASMT. VILL AIR ✓ OTHER
 STRESS RELIEVED: YES ✓ CODE
 RADIOGRAPHED: YES ✓ CODE
 BATHOLAKE: WED PSIG

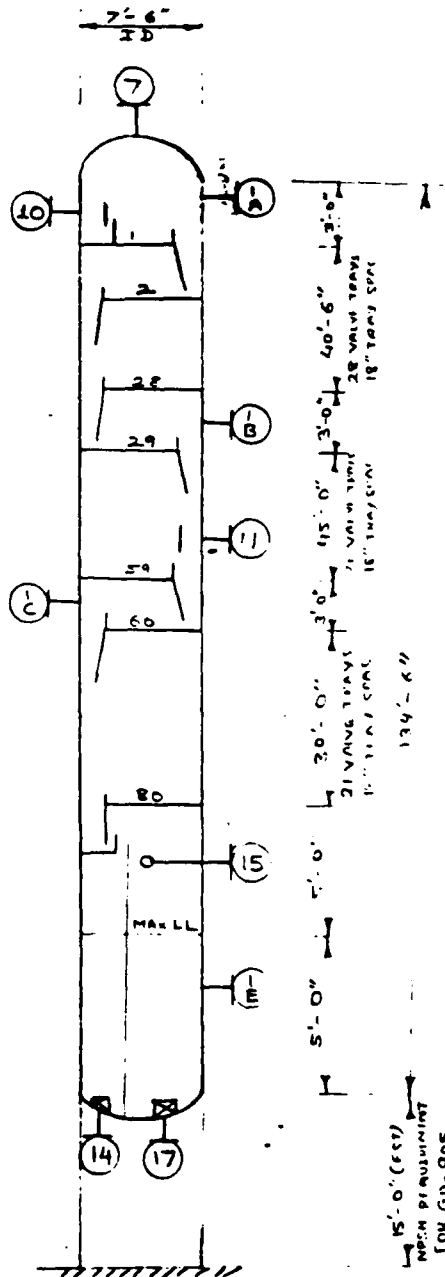
MATL: SHLL CS LINER ✓ TIE ✓
 INSULATION: CONSERV ✓ PROTECT ✓ NONE
 DECK MATL: CS VALVE MATL: 304SS

NOZZLE: FLG CLASS 150 COUP. CLASS

ITEM NO.	SIZE	SERVICE & SYMBOL
1	24	MANHOLE
2		MANHOLE
3		
4		
5		MANHOLE
6		
7	18	VAPOR OUTLET TO <u>EA-906</u>
8		TO VACUUM EQUIPMENT
9		REFLUX IN FROM <u>FA-903</u>
10	1 1/2	FEED FROM <u>GA-901</u>
11		FEED FROM
12		FEED FROM
13		FEED FROM
14	8	TO REBOILER (REFLUX) <u>EA-905</u>
15	18	FROM REBOILER <u>EA-905</u>
16		EQUALIZING LINE WITH
17	15	BOTTOM OUTLET TO <u>GA-905</u>
18		LIQUID OUTLET TO
19		DRAWOFF TO
20		RETURN FROM
21		DRAWOFF TO
22		RETURN FROM
23		DRAWOFF TO
24		RETURN FROM
25		REFLUX DRAFF TO
26		REFLUX IN FROM
27		REFLUX DRAFF TO
28		REFLUX IN FROM
29		PROCESS STREAM
30		STEAM OFF (S)
31		DRAIN
32		SAMPLE COHN (S) COOLER (S)
33		SAFETY VALVE (SV)
34		SAFETY VALVE (SV) (V)
35		UTILITY CONNECTION
36		PRESSURE GAGE (PG)
37		PRESSURE CONTROLLER (P) <u>LD</u>
38		PRESSURE TAP (PT)
39		
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (T) <u>LD</u>
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44		
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49		
50		

FLANGED NOZZLES ARE
 NUMBERED 1-10.
 FOR COUPLING ADD
 50 TO NOZZLE NO.

NOTE: LIG SP GR = 0.87 (avg) @ operating temp.



△									
△	MIN	4	For TMR 4						
REV	DATE	DESCRIPTION	PROJ.	DES.	APP.	DATE	DATE	DATE	DATE

		THE LUMMUS COMPANY	
WMS JET FUELS PROJECT PLANT NO. 1000 - LOCATION BEULAH, NORTH DAKOTA PLANT NO. 1000 - LOCATION BEULAH, NORTH DAKOTA			
PROCESS VESSEL SKETCH			
VESSEL NO. <u>DA-903</u>		DWS NO. <u>-</u>	

CE LUM
BY SUNIL
COLUMN 903 CRESYLIC ACID RECOVERY

VALVE TRAY COMPUTER PROGRAM 4-9219
USED AT 12.5% ON 80/11/11.

DATE 03 APR 25 1986
DESIGN - FINE ROUND 10 SKF

ATCH
LUMMS JOB OR ESTIMATE 2211
JEST 302 OFFICE LTD

LAYOUT DIMENSIONS

TRAY SPACING, INCHES 14.000
TYPE OF FLOW SKF (1-PASS) INSIDE TRAY DIAMETER, INCHES 90.00

DESIGN LOADS VAPOR RATE VAPOR DENSITY LIQUID RATE LIQUID DENSITY SURFACE TENSION LIQUID VISCOSITY
LBS/MR LBS/FT³ LBS/HR LBS/FT³ DYNES/CM CENTIPOISE

MAXIMUM = 39900.00 .03000 34300.00 57.83000 25.20 .36400
(BASED ON OVERDESIGN TO 100.0 O/D OF VAPOR AND TO 100.0 O/D OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY)

MINIMUM = 31171.70 .00900 33344.50 53.60000 70.14 .28600
(BASED ON TURNDOWN TO 70.0 O/D OF VAPOR AND TO 70.0 O/D OF LIQUID NOMINAL RATES FOR MINIMUM LOADED TRAY)

DOWNCOMER LOCATION 1=SIDE
DOWNCOMER TYPE 2= SLOPING
INLET WEIR

DIMENSIONS AT TOP OF DOWNCOMER, INCHES

DOWNCOMER WIDTH INOTE 11 9.000
DOWNCOMER PLATE TO SHELL DISTANCE 9.000
OUTLET WEIR HEIGHT 1.000
HEIGHT OF OUTLET WEIR NOTCH 1.500
OUTLET WEIR LENGTH INOTE 21 54.000
C-CORD LENGTH AT DOWNCOMER PLATE INOTE 21 54.000

DIMENSIONS AT BOTTOM OF DOWNCOMER, INCHES

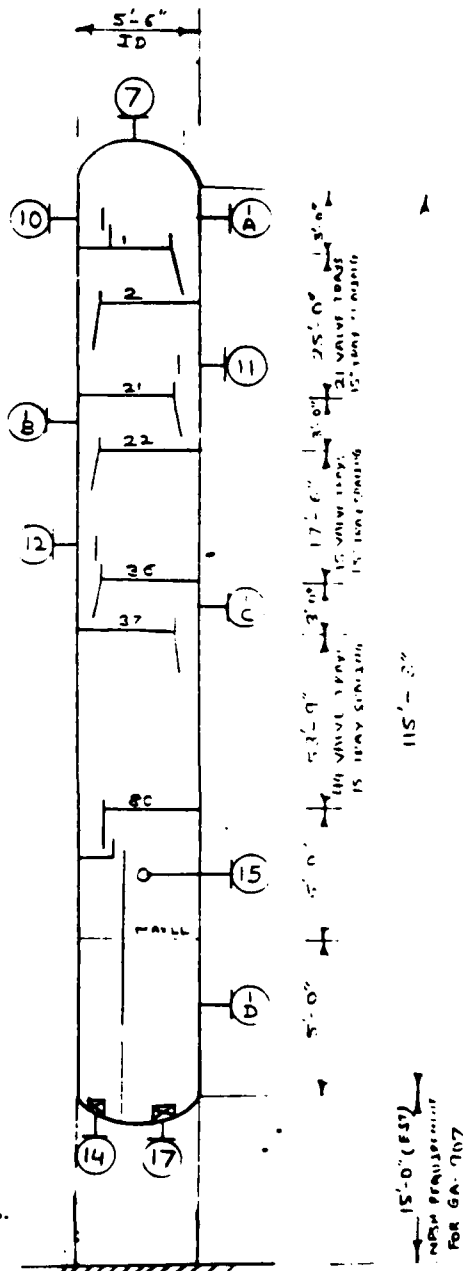
DOWNCOMER WIDTH INOTE 11 6.500
DOWNCOMER CLEARANCE INOTE 31 .750
DOWNCOMER BOTTOM TO TRAY INLET INOTE 41 2.500
INLET WEIR HEIGHT 1.250
INLET WEIR LENGTH INOTE 21 54.000
DOWNCOMER PLATE TO SHELL DISTANCE 5.500
LENGTH OF DOWNCOMER PLATE INOTE 21 46.594
INLET WEIR TO SHELL DISTANCE 9.000
C-CORD LENGTH AT INLET WEIR INOTE 21 54.000

NOTE 1 - PER DOWNCOMER, NOTE 2 - PER DOWNCOMER PLATE, NOTE 3 - DIMENSION ABOVE TRAY FLOOR, NOTE 4 - HORIZONTAL DISTANCE


NOTE 5 - 0 INDICATES SPECIAL TRAY FEATURE

0 0 0 0 0 ATTACH THIS SHEET TO THE VALVE TRAY DATA SHEET TO MAKE A PROCESS SPECIFICATION FOR THIS TRAY 0 0 0 0 0

NOTE: LIA SP. 622 088 (avg) @ operating temp.



△							
△	WIND BY	FOR TASK 4		SL			
REV	ISSUE DATE	DESCRIPTION		PRICE PER LB	PAID		

	LUMMUS	THE LUMMUS COMPANY Houston
TITLE JET FUEL PROJECT		
CLIENT AND/OR OFFICE LOCATION BIELAN, NORTH PLAINS PROJECT JOB NO 05571		
PROCESS VESSEL SKETCH		
DATE 10 DA 90L	DWG NO -	

CE LUMP
BY SUMIL
COLUMN 904 CRESYLIC ACID RECOVERY

VALVE TRAY COMPUTER PROGRAM 4-9217
JSED AT 12:59:26 ON 08/11/11.
RELEASED 03 DATED APR 25 1986
DESIGN - FINE KUNIND J TO SKF

DATE 4
LUMP/JS JUN 04 ESTIMATE 571
DEPT 302 OFFICE LTD

LAYOUT DIMENSIONS

TRAY SPACING, INCHES
TYPE OF FLOW

DESIGN LOADS
VAPOR RATE
LBS/HR

VAPOR DENSITY
LBS/FT3

LIQUID RATE
LBS/HR

LIQUID DENSITY
LBS/FT3

SURFACE TENSION
DYNES/CM

LIQUID VISCOSITY
CENTIPOISE

INSIDE
LOWER DIAMETER, INCHES

MAXIMUM = 18703.03
(BASED ON OVERDESIGN TO 100.0 O/D OF VAPOR AND TO 100.0 O/D OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY)

MINIMUM = 14318.53
(BASED ON TURNDOWN TO 70.0 O/D OF VAPOR AND TO 70.0 O/D OF LIQUID NOMINAL RATES FOR MINIMUM LOADED TRAY)

DOWNCOMER LOCATION
DOWNCOMER TYPE

DIMENSIONS AT TOP OF DOWNCOMER, INCHES

DOWNCOMER WIDTH
DOWNCOMER PLATE TO SHELL DISTANCE

OUTLET WEIR HEIGHT
ONEIGHT OF OUTLET WEIR NOTCH

OUTLET WEIR LENGTH
C-WORD LENGTH AT DOWNCOMER PLATE

DIMENSIONS AT BOTTOM OF DOWNCOMER, INCHES

DOWNCOMER WIDTH
DOWNCOMER CLEARANCE

DOWNCOMER BOTTOM TO TRAY INLET
INLET WEIR HEIGHT

INLET WEIR LENGTH
DOWNCOMER PLATE TO SHELL DISTANCE

LENGTH OF DOWNCOMER PLATE
INLET WEIR TO SHELL DISTANCE

C-WORD LENGTH AT INLET WEIR

NOTE 1 - PER DOWNCOMER, NOTE 2 - PER DOWNCOMER PLATE, NOTE 3 - DIMENSION ABOVE TRAY FLOOR, NOTE 4 - HORIZONTAL DISTANCE

NOTE 5 - NUMBERS IN () REFER TO THE APPLICABLE MESSAGES ON THE DIAGNOSTICS SHEET * NOTE 6 - * INDICATES SPECIAL TRAY FEATURE

* * * * * ATTACH THIS SHEET TO THE VALVE TRAY DATA SHEET TO MAKE A PROCESS SPECIFICATION FOR THIS TRAY * * * * *

ITEM NUMBER	SERVICE	MATERIAL	HEAT EXCHANGER MEDIUM					TEMPERATURE OF			DUTY 1000 Btu/hr	OVERALL HEAT TRANS COEFF Btu/hr-sq ft	FOUL FACTOR 1/2 in-sq ft	TOTAL SURFACE 32	MAX ALLOWABLE PRESS DROP IN	PRESS. DWG		SIZE AND TYPE	MATERIALS
			FLOW	SPECIFIC GRAVITY	MOLECULAR WEIGHT	VISCOSITY AT AVG TEMP	% VAPORIZED BY WEIGHT	% CONDENSED BY WEIGHT	IN	OUT						OPERATING	DESIGN		
EA 901	Phenol Condenser	Shell	HP STEAM	86.5					210	110	7000					50	50	REM	CS
EA 902	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 903	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 904	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 905	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 906	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 907	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 908	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 909	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 910	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 911	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 912	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 913	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 914	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 915	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS
EA 916	Phenol Condenser	Shell	Phenol	210	110				210	110	7000					50	50	REM	CS

ITEM NUMBER	ALTER NOTE - SERVICE FOR TIO AIRA FERRING	DOE	HEAT EXCHANGER MEDIUM					TEMPERATURE OF			DUTY TONS REFR	OVERALL HEAT TRANS COEFF Btu/h ft ² °F	FOUL FACTOR 1/2 x 12 of	TOTAL SURFACE ft ²	MAX ALLOWABLE PRESS DROP PSI	PRESS PSI		SIZE AND TYPE		MATERIALS		
			MATERIAL	FLOW RATE	SPECIFIC GRAVITY	MOLECULAR WEIGHT	VISCOSITY AT AVG TEMP CP	EVAPORATED BY WEIGHT	CONDENSED BY WEIGHT	IN						OUT	CONC MTD	DESIGN TEMP	OPERATING	DESIGN	NO LAMINAR AND G.D BY LENGTH	TYPE TUBES
EA 901	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER
EA 902	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER
EA 903	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER
EA 904	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER
EA 907	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER
EA 908	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER
EA 909	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER
EA 910	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER
EA 911	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER	CONDENSER

VESSEL NO. FA-901 COME WITH
 VESSEL NAME PHENOL-ORING REFLUX DRUM / ORING TOPPING REFLUX DRUM
 DIAMETER 36" (Allowance Service)

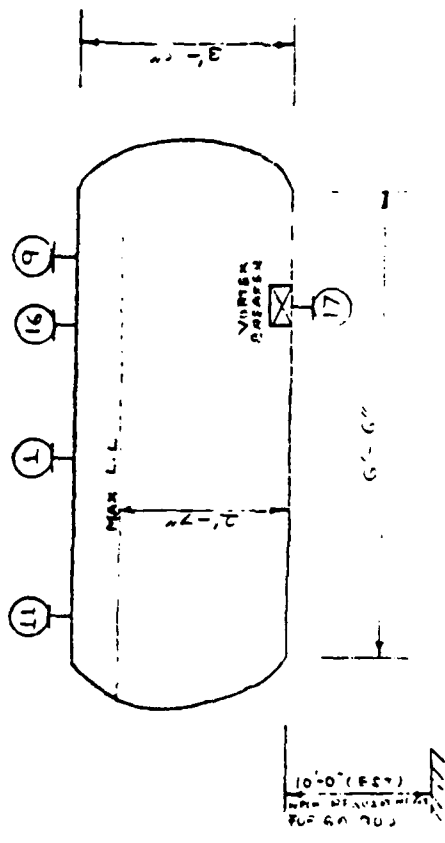
VENT HT. 8"
 NOZZLE LENGTH 6'-6" R-400
 OPER. TEMP. TOP 255 °F BOT. 255 °F
 MAX TEMP. TOP 255 °F BOT. 255 °F
 NORM. OPER. PRESS. 92 PSIG OR 92 PSIA
 MAX. OPER. PRESS. 92 PSIG OR 92 PSIA
 CORROSION ALLOW. 3/16" SHELL 3/16" DECK
 DES. TEMP. 280 °F
 DES. PRESS. 45 PSIG VAC. EVU
 HEAD: SLIP DISHED ✓ CONE ✓ FLAT ✓
 CODE: ASME U-1 U-2 U-3 U-4 U-5 U-6 U-7 U-8 U-9 U-10
 STRESS RELIEVED YES CODE U-1 OTHER U-2
 RADIOGRAPHED YES CODE U-1
 EARTHQUAKE WIND SEISMIC

MATL: SHELL CS LINER CS THK. 1/2"
 INSULATION: CONSERV ✓ PROTECT ✓ NONE ✓
 DECK MATL: CS

NOZZLES: FLG CLASS 150 COUPL. CLASS 150

ITEM NO.	NO.	SIZE	SERVICE & SYMBOL
1	1	18"	MANHOLE
2	2	18"	MANHOLE
3	3		
4	4		
5	5		HANDHOLE
6	6		
7	7		VAPOR OUTLET TO
8	8		VENT
9	9		TO VACUUM EQUIPMENT
10	10		REFLUX IN FROM
11	11		FEED FROM <u>EA-902</u>
12	12		FEED FROM
13	13		FEED FROM
14	14		TO REBOILER (REB. PUMP)
15	15		FROM REBOILER
16	16		EQUALIZING LINE WITH <u>EA-902</u>
17	17		BOTTOM OUTLET TO <u>EA-902</u>
18	18		LIQUID OUTLET TO
19	19		DRAWOFF TO
20	20		RETURN FROM
21	21		DRAWOFF TO
22	22		RETURN FROM
23	23		DRAWOFF TO
24	24		RETURN FROM
25	25		REFLUX DRAWOFF TO
26	26		REFLUX IN, FROM
27	27		REFLUX DRAWOFF TO
28	28		REFLUX IN, FROM
29	29		PROCESS STEAM
30	30		STEAM OUT (SO)
31	31		DRAIN
32	32		SAMPLE CONN. (S), COOLER (CO)
33	33		SAFETY VALVE (SV)
34	34		SAFETY VALVE (PSV) (SV)
35	35		UTILITY CONNECTION
36	36		PRESSURE GAGE (PG)
37	37		PRESSURE CONTROLLER (PC) <u>Q</u>
38	38		PRESSURE TAP (PT)
39	39		
40	40		TEMPERATURE INDICATOR (TI)
41	41		TEMPERATURE CONTROLLER (TC) <u>Q</u>
42	42		TEMPERATURE RECORDER (TR)
43	43		TEMPERATURE WELL (TW)
44	44		
45	45		GAUGE GLASS (GG)
46	46		EXTERNAL LEVEL
47	47		INTERNAL LEVEL
48	48		LEVEL ALARM (LA)
49	49		
50	50		

FLANGED NOZZLES ARE
 DIMENSIONED 1/2"
 FOR COUPLING ADD
 50 TO NOZZLE NO.



NOTES: Welded SP GR = 0.87 @ operating temp.

		THE LUMMUS COMPANY	
		Birmingham	
TITLE <u>JET FUELS PROJECT</u> CLIENT <u>AMSC/DOE-ORNL</u> LOCATION <u>BEULAH, NORTH DAKOTA</u> PROJECT <u>JET FUELS PROJECT</u> JOB NO. <u>05571</u>			
PROCESS VESSEL SKETCH			
VESSEL NO. <u>FA-901</u>		PAGE NO. <u>1</u>	

REV	DATE	DESCRIPTION	PROJ. ENGINEER	PROJ. MANAGER	APPROV.	DATE
1	4/14/55	FOR TASK 4				

VESSEL NO. FA-902 COMB WITH
 VESSEL NAME PHENOL REFLUX DRUM / O-CHLOROPHENOL REFLUX DRUM (Alternate Service)
 DIAMETER 3'-0" H-1 SHORT
 VERT HT 5'-0" H-1 SHORT
 NOZZLE LENGTH 5'-0" H-1 SHORT
 OPER TEMP TOP 285 °F BOT 280 °F DRUM 280 °F
 MAX TEMP TOP 285 °F BOT 280 °F DRUM 280 °F
 NOZZLE OPER PRESS 1.93 PSIG OR 1.93 PSIA
 MAX OPER PRESS 1.93 PSIG OR 1.93 PSIA
 CORROSION ALLOW SHELL 2.5 IN DECKS 0 IN

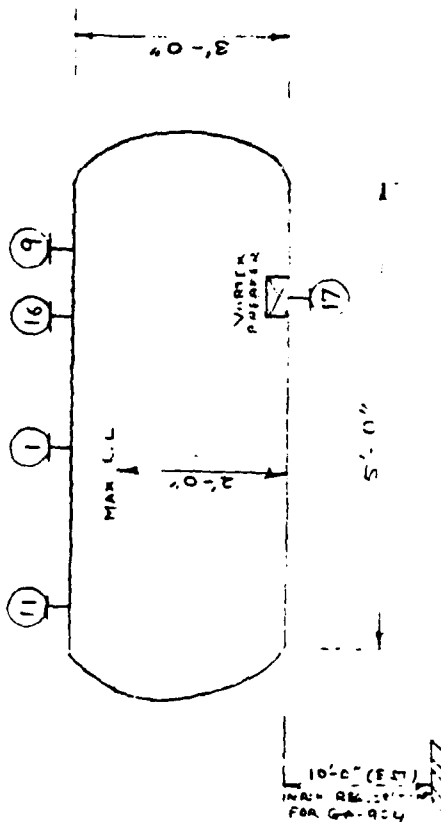
DES TEMP 285 °F
 DES PRESS 4.5 PSIG VAC FULL PSIG
 HEADS ELIP DISHED CONE FLAT
 CODE ASME VIII AM OTHER
 STRESS RELIEVED YES ✓ CODE
 RADIOGRAPHED YES ✓ CODE
 EARTHQUAKE YES ✓ WIND YES

MATL SHELL CS LIVER THK
 INSULATION CONSERV ✓ PROTECTN NONE
 DECK MATL ISD

NOZZLES FLG CLASS 15C COUPL CLASS

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1	1	18	MANHOLE
2			MANHOLE
3			
4			
5			MANHOLE
6			
7			VAPOR OUTLET TO
8			VENT
9	1	2	TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11	1	3	FEED FROM <u>EA 904</u>
12			FEED FROM
13			FEED FROM
14			TO REBOILER (REB. PUMP)
15			FROM REBOILER
16	1	1/2	EQUALIZING LINE WITH <u>EA 904</u>
17	1	3	BOTTOM OUTLET TO <u>GA 904</u>
18			LIQUID OUTLET TO
19			DRAWOFF TO
20			RETURN FROM
21			DRAWOFF TO
22			RETURN FROM
23			DRAWOFF TO
24			RETURN FROM
25			REFLUX DRAWOFF TO
26			REFLUX IN FROM
27			REFLUX DRAWOFF TO
28			REFLUX IN FROM
29			PROCESS STEAM
30			STEAM OUT (SO)
31			DRAIN
32			SAMPLE CONN. (EL. COOLER (SC)
33			SAFETY VALVE (PSV)
34			SAFETY VALVE (PSV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAUGE (PG)
37			PRESSURE CONTROLLER (P) <u>Q</u>
38			PRESSURE TAP (PT)
39			
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T) <u>Q</u>
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO



NOTES: LIQUID SP GR = 0.98 @ operating temp.

		THE LUMMUS COMPANY	
		BOSTON	
TITLE JET FUEL PROJECT CLIENT AMOCO/DOE-ORIGINATOR BEULAH NORTH RAJNE GULF PROJECT DAFOA PROJECT NO 05571			
PROCESS VESSEL SKETCH			
VESSEL NO FA-902		DWS SKS -	

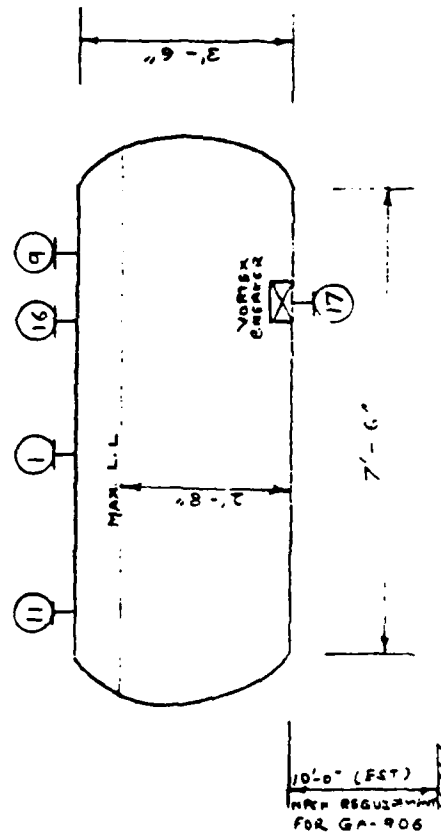
REV	DATE	DESCRIPTION	PROJ. ENGINEER	PROJ. CHECKER	APPR.	APPR.
1	4/1/77	FOR TANK 4				

VESSEL NO. FA-903 COME WITH
 VESSEL NAME H.P. CIRCUL. REFLEX DRYM
 DIAMETER 3'-6" R-IN 8 R-OUT
 VENT HT. 7'-6" R-IN 8000 R-OUT
 NOZZLE LENGTH 7'-6" R-IN 8000 R-OUT
 OPER. TEMP. TOP 310 °F BOT. 45 °F DRUM 285 °F
 MAX. TEMP. TOP 310 °F BOT. 45 °F DRUM 285 °F
 NORM. OPER. PRESS. 1.93 PSIG OR 1.93 PSIA
 MAX. OPER. PRESS. 1.93 PSIG OR 1.93 PSIA
 CORROSION ALLOW. SHELL 1/8" IN DECKS 1/8" IN
 DES. TEMP. 310 °F
 DES. PRESS. 45 PSIG VAC. FULL 1 PSIG
 HEAD. SHIP DISHED ✓ CODE DOSE PLAT
 CODE ASME U-2 AP OTHER
 STRESS RELIEVED YES ✓ CODE
 RADIOGRAPHED YES CODE
 EARTHQUAKE WIND RSH

MATL: SHELL CS LINER TSK
 INSULATION CONSERVYN ✓ PROTECTN NONE
 DECK MATL

NOZZLES, PLS. CLASS		ISO	COUPL. CLASS	
ITEM NO.	NO.	SIZE	SERVICE & SYMBOL	
1	1	1/2"	MANHOLE	
2			MANHOLE	
3				
4			MANHOLE	
5				
6				
7			VAPOR OUTLET TO	
8			VENT	
9			TO VACUUM EQUIPMENT	
10	1	2"	REFLUX IN FROM	
11	1	4"	FEED FROM <u>FA-906</u>	
12			FEED FROM	
13			FEED FROM	
14			TO REBOILER (P/R PUMP)	
15			FROM REBOILER	
16	1	1 1/2"	EQUALIZING LINE WITH <u>FA-906</u>	
17			BOTTOM OUTLET TO <u>GA-906</u>	
18			LIQUID OUTLET TO	
19			DRAWOFF TO	
20			RETURN FROM	
21			DRAWOFF TO	
22			RETURN FROM	
23			DRAWOFF TO	
24			RETURN FROM	
25			REFLUX DRAWOFF TO	
26			REFLUX IN FROM	
27			REFLUX DRAWOFF TO	
28			REFLUX IN FROM	
29			PROCESS STEAM	
30			STEAM OUT (SO)	
31			DRAIN	
32			SAMPLE CONN. (S) COOLER (CO)	
33			SAFETY VALVE (PSV)	
34			S. FETY VALVE (PSV) (MSV)	
35			UTILITY CONNECTION	
36			PRESSURE GAUGE (PG)	
37			PRESSURE CONTROLLER (P) <u>Q</u>	
38			PRESSURE TAP (PT)	
39				
40			TEMPERATURE INDICATOR (TI)	
41			TEMPERATURE CONTROLLER (T) <u>Q</u>	
42			TEMPERATURE RECORDER (TR)	
43			TEMPERATURE WELL (TW)	
44				
45			GAUGE GLASS (GG)	
46			EXTERNAL LEVEL	
47	1		INTERNAL LEVEL	
48			LEVEL ALARM (LA)	
49				
50				

PLANNED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO.



NOTES
 LIQUID SG GR = 0.93 @ operating temp.

		THE LUMMUS COMPANY	
TITLE: JET FUELS PROJECT CLIENT: AND/OR: GALT, LOCATION: SULLY, NORTH DAKOTA PLANT: GALT, REV: 05571		PROCESS VESSEL SKETCH	
REV	DATE	DESCRIPTION	APPROVED
1	1/11/58	FOR TANK 4	AL
VESSEL NO. FA-903		DWS 510 -	

VESSEL NO. FA 904 COMB WITH
 VESSEL NAME 1X1 ENO TOPPING FILL 200W/24-35 LEND. REFUM. DRUM
 (AIR SERVICE)
 DIAMETER 3'-0" H-40
 VERT HT 5'-0" H-40
 NOZ. LENGTH 5'-0" H-40
 OPER TEMP. TOP 7 BOTT 7 DRUM 21.5 T
 MAX TEMP. TOP 7 BOTT 7 DRUM 7 T
 NORM OPER PRESS 7 BOTT 7 DRUM 7 T
 MAX OPER PRESS 7 BOTT 7 DRUM 7 T
 CORROSION ALLOW. SHELL 2 DISKS 2 H

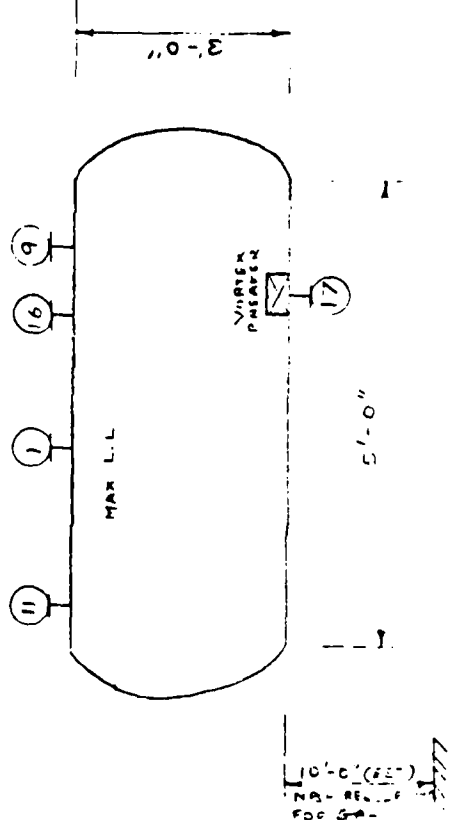
DES TEMP 32.0 T
 DES PRESS 45 H-40 VAC FULL H-40
 HEADS. SLIP DISHED H-40 CONE FLAT H-40
 CODE. ASME U-1 API OTHER H-40
 STRESS RELIEVED: YES ✓ CODE OTHER H-40
 RADIOGRAPHED: YES ✓ CODE OTHER H-40
 EARTHQUAKE: YES ✓ CODE OTHER H-40

MATL. SHELL CS LINER THK H-40
 INSULATION CONSERVYN ✓ PROTECTYN NOVE H-40
 DECK MATL. NOVE H-40

NOZZLES. FLG CLASS 150 COUPL. CLASS 150

ITEM NO.	NO.	SIZE	SERVICE & SYMBOL
1	1	18	MANHOLE
2	2	18	MANHOLE
3	3	18	MANHOLE
4	4	18	MANHOLE
5	5	18	MANHOLE
6	6	18	MANHOLE
7	7	18	MANHOLE
8	8	18	MANHOLE
9	9	18	MANHOLE
10	10	18	MANHOLE
11	11	18	MANHOLE
12	12	18	MANHOLE
13	13	18	MANHOLE
14	14	18	MANHOLE
15	15	18	MANHOLE
16	16	18	MANHOLE
17	17	18	MANHOLE
18	18	18	MANHOLE
19	19	18	MANHOLE
20	20	18	MANHOLE
21	21	18	MANHOLE
22	22	18	MANHOLE
23	23	18	MANHOLE
24	24	18	MANHOLE
25	25	18	MANHOLE
26	26	18	MANHOLE
27	27	18	MANHOLE
28	28	18	MANHOLE
29	29	18	MANHOLE
30	30	18	MANHOLE
31	31	18	MANHOLE
32	32	18	MANHOLE
33	33	18	MANHOLE
34	34	18	MANHOLE
35	35	18	MANHOLE
36	36	18	MANHOLE
37	37	18	MANHOLE
38	38	18	MANHOLE
39	39	18	MANHOLE
40	40	18	MANHOLE
41	41	18	MANHOLE
42	42	18	MANHOLE
43	43	18	MANHOLE
44	44	18	MANHOLE
45	45	18	MANHOLE
46	46	18	MANHOLE
47	47	18	MANHOLE
48	48	18	MANHOLE
49	49	18	MANHOLE
50	50	18	MANHOLE

PLANGED NOZZLES ARE
 NUMBERED 1-80
 FOR COUPLING ADD
 80 TO NOZZLE NO



NOTES: LIQUID SP. GR. = 0.87 @ operating temp.

		THE LUMMUS COMPANY	
		Standard	
TITLE: JET FUELS PROJECT			
CLIENT: AMBROSIO DIST. LOCATION: SULLY, NORTH DAKOTA			
PLANT: GALT PNTJ JOB NO: 05371			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	APP. APP.
1	11/14/81	FOR TAIL 4	21
VESSEL NO. FA 904		DWS 810 -	

ITEM NO.	SERVICE	PUMP TYPE	LIQUID	CORR. REOS. CAUSED BY	PUMPING TEMP. °F	OR AIR AT PT. PRA	LIQ. PRESS. AT PT. PRA	VISC. CP	CAPACITY L/GPM	ORIENT. PRES. RATED	DIFF. HEAD. FT.	DIFF. HEAD. PSI	WAT. CLAMP IN	PLANS RATING/FACING BACK	DRIVER TYPE	REMARKS
GA-901/15	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
Air Service	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-902/16	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-903/17	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-904/18	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-905/19	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-906/20	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-907/21	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-908/22	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-909/23	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-910/24	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-911/25	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-912/26	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-913/27	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	
GA-914/28	HEAT EXCH. PUMP	CENTRIFUGAL	WATER		360	0.86	10.5	0.27	15.2	0	120	12	12		MOTOR	

VESSEL NO FR-701 COMB WITH _____
 VESSEL NAME 2-2000 GALLON FUEL DAY TANK
 DIAMETER 16'-0" H-H 8 H-H 8
 VERT HT 16'-0" H-H SHIRT H-H SHIRT
 HORIZ LENGTH _____ H-H 11'-3" H-H 11'-3"
 OPER TEMP TOP _____ ° F BOTM _____ ° F DRUM _____ ° F
 MAX TEMP TOP _____ ° F BOTM _____ ° F DRUM _____ ° F
 NORM OPER PRESS _____ PSIG OR _____ PSIA
 MAX OPER PRESS 6" H₂O PSIG OR _____ PSIA
 CORROSION ALLOW SHELL 2" IN DECKS _____ IN

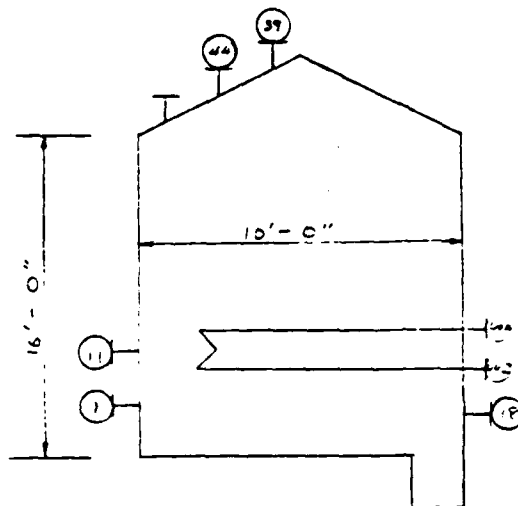
DES TEMP 230 ° F
 DES PRESS 8" H₂O PSIG VAC -2" H₂O PSIA
 HEADS ELIP _____ DISHED _____ CONE ROOF FLAT 80° TO H
 CODE ASME _____ API X OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ MPH

MATL SHELL CS LINER _____ THK _____ IN
 INSULATION CONSERV X PROTECTN _____ NONE
 DECK MATL _____

NOZZLES FLO CLASS _____ COUPL CLASS _____

ITEM NO	SIZE	SERVICE & SYMBOL
NO	REQD	"
1	<u>24</u>	MANHOLE (H-H)
2		MANHOLE
3		
4		
5		HANDHOLE
6		
7		VAPOR OUTLET TO
8		VENT
9		TO VACUUM EQUIPMENT
10		REFLUX IN FROM
11	<u>1/2</u>	FEED FROM <u>2-F-9-2</u>
12		FEED FROM
13		FEED FROM
14		TO REBOILER-HEB PUMP
15		FROM REBOILER
16		EQUALIZING LINE WITH
17		BOTTOM OUTLET TO
18	<u>2</u>	LIQUID OUTLET TO <u>2-F-9-2</u>
19		DRAWOFF TO
20		RETURN FROM
21		DRAWOFF TO
22		RETURN FROM
23		DRAWOFF TO
24		RETURN FROM
25		REFLUX DRAFF TO
26		REFLUX IN FROM
27		REFLUX DRAFF TO
28		REFLUX IN FROM
29		PROCESS STEAM
30		STEAM OUT (SO)
31		DRAIN
32		SAMPLE CONN (S), COOLER (CO)
33		SAFETY VALVE (SV)
34		SAFETY VALVE (PSV) (NSV)
35		UTILITY CONNECTION
36		PRESSURE GAGE (PG)
37		PRESSURE CONTROLLER (P) _____ C
38		PRESSURE TAP (PT)
39	<u>1/2</u>	<u>2-F-9-2</u>
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (T) _____ C
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44	<u>1</u>	<u>2-F-9-2</u>
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49	<u>2</u>	<u>STEAM COIL</u>
50		

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 80 TO NOZZLE NO



NOTES: 1. ID SPGR = 1.03 @ operating temp

2. STEAM COIL TO MAINTAIN 100 F

		THE LUMMUS COMPANY	
		TITLE <u>JET FUEL PROJECT</u> CLIENT <u>AMCO/D&E</u> LOCATION <u>BEULAH, ND</u> PROJ NO _____ JOB NO <u>05571</u>	
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	VESSEL NO <u>FR-701</u> DWG NO <u>-</u>
1	4/14/79	FOR TANK 4	

VESSEL NO FG-902 COMB WITH _____
 VESSEL NAME HYDROLYSIS TANK
 DIAMETER 10'-0" H-H 8 R-H 8
 VERT HT 8'-0" H-H BUILT _____ R-H _____
 HORIZ LENGTH _____
 OPER TEMP TOP _____ ° BOTT _____ ° DRUM 113 °
 MAX TEMP TOP _____ ° BOTT _____ ° DRUM _____ °
 NORM OPER PRESS _____ PSI DR _____ PSI
 MAX OPER PRESS 6 H₂O _____ PSI
 CORROSION ALLOW SHELL _____ IN DECK _____ IN

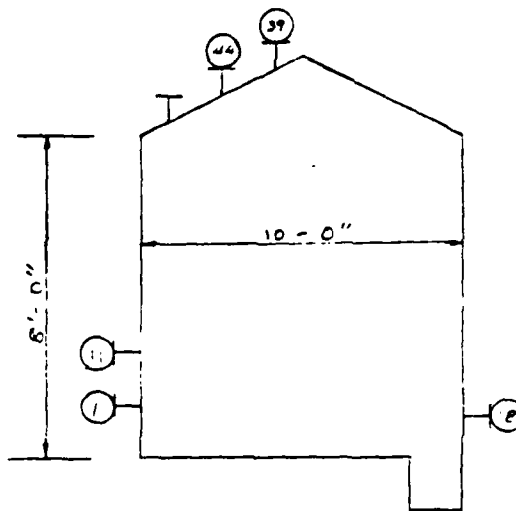
DES TEMP 230 °
 DES PRESS 8 H₂O _____ VAC -2 H₂O _____
 HEADS ELP _____ DISHED _____ CONE ROOF FLAT BOTTOM
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ PSI

MATL SHELL CS LINER _____ THK _____ IN
 INSULATION CONSERV'N X PROTECT'N _____ NONE
 DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1	<u>1</u>	<u>24</u>	MANHOLE
2			MANHOLE
3			
4			
5			MANHOLE
6			
7			VAPOR OUTLET TO _____
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM _____
11	<u>11</u>	<u>1/2</u>	FEED FROM <u>GA-905</u>
12			FEED FROM _____
13			FEED FROM _____
14			TO REBOILER (REB PUMP)
15			FROM REBOILER
16			SQUALZING LINE WITH _____
17			BOTTOM OUTLET TO _____
18	<u>1</u>	<u>2</u>	LIQUID OUTLET TO <u>GA-912</u>
19			DRAWOFF TO _____
20			RETURN FROM _____
21			DRAWOFF TO _____
22			RETURN FROM _____
23			DRAWOFF TO _____
24			RETURN FROM _____
25			REFLUX DRAFF TO _____
26			REFLUX IN FROM _____
27			REFLUX DRAFF TO _____
28			REFLUX IN FROM _____
29			PROCESS STEAM
30			STEAM OUT (SO)
31			DRAIN
32			SAMPLE CONN (S) COOLER (CO)
33			SAFETY VALVE (SV)
34			SAFETY VALVE (PSV) (NSV)
35			UTILITY CONNECTION
36			PRESSURE CAGE (PC)
37			PRESSURE CONTROLLER (P) _____ C
38			PRESSURE TAP (PT)
39	<u>1</u>	<u>1/2</u>	<u>GA-905</u> <u>1/2</u>
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (TC) _____ C
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44	<u>1</u>	<u>4</u>	<u>GA-905</u> <u>4</u>
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO



NOTES: WOULD SPGR = 0.95 at operating temp

		THE LUMMUS COMPANY	
		Houston, Texas	
TITLE <u>JET FUEL PROJECT</u> CLIENT <u>AMMO/DGE</u> LOCATION <u>SEULAN, ND</u> PROJ NO _____ JOB NO <u>05571</u>			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	VESSEL NO <u>FG-902</u> SHEET NO <u>1</u>
1	6/14/73	FOR TASK 4	

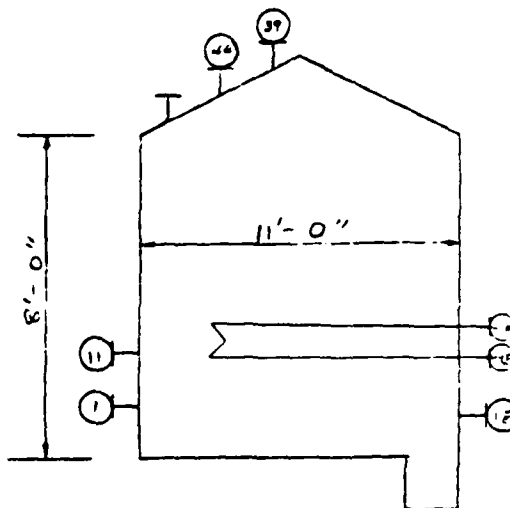
VESSEL NO. FR-903 COME WITH
 VESSEL NAME 0-REF-1 PROD. 1 DAY TANK
 DIAMETER 11'-0" H-8 8 S-4
 VENT HT. 8'-0" S-4 BLURT 8-4
 NOSE LENGTH 8'-0" S-4
 OPER TEMP: TOP 4 BOT 4 DRAIN 113 4
 MAX TEMP: TOP 4 BOT 4 DRAIN 4
 NORM OPER PRESS 6 H₂O 6 OR 6
 MAX OPER PRESS 6 H₂O 6 OR 6
 CORROSION ALLOW: SHELL 2-- IN SECS 2 IN

SER TEMP 230 4
 SER PRESS 8" H₂O SER VAC -2" H₂O SER
 HEADS: S.P. DESIGN DESIGN ROOF PLAT 80" TO M
 CODE: ASME AS OTHER
 STRESS RELIEVED: YES CODE
 RADIOGRAPHED: YES CODE
 EARTHQUAKE: YES NO SP

MATL: SHELL CS LINER TK IN
 INSULATION: CONSERV Y PROTECT NO NO
 DECK MATL:

NOZZLE: FLG CLASS COUP CLASS

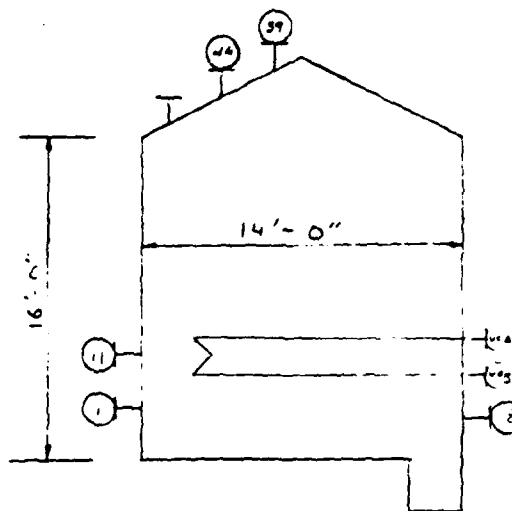
ITEM NO	SIZE	SERVICE & SYMBOL
1	<u>2 1/2</u>	MANHOLE
2		MANHOLE
3		MANHOLE
4		MANHOLE
5		MANHOLE
6		MANHOLE
7		MANHOLE
8		MANHOLE
9		MANHOLE
10		MANHOLE
11		MANHOLE
12		MANHOLE
13		MANHOLE
14		MANHOLE
15		MANHOLE
16		MANHOLE
17		MANHOLE
18		MANHOLE
19		MANHOLE
20		MANHOLE
21		MANHOLE
22		MANHOLE
23		MANHOLE
24		MANHOLE
25		MANHOLE
26		MANHOLE
27		MANHOLE
28		MANHOLE
29		MANHOLE
30		MANHOLE
31		MANHOLE
32		MANHOLE
33		MANHOLE
34		MANHOLE
35		MANHOLE
36		MANHOLE
37		MANHOLE
38		MANHOLE
39		MANHOLE
40		MANHOLE
41		MANHOLE
42		MANHOLE
43		MANHOLE
44		MANHOLE
45		MANHOLE
46		MANHOLE
47		MANHOLE
48		MANHOLE
49		MANHOLE
50		MANHOLE







NOTES: 1. 1000 S.P. = 102 @ operating temp
 2. STEAM COIL TO MAINTAIN 100°F

		THE LUMMUS COMPANY (Incorporated)	
TITLE: JET FUEL PROTECT CLIENT: AMCO/DOE LOCATION: SEULAN, ND PROJECT: DOE 71			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	VESSEL NO FR-903 SER NO -

NOZZLES P/LB CLASS			COUPL. CLASS	
ITEM	NO	SIZE	SERVICE & SYMBOL	
	REGO	P.		
1	1	24	MANHOLE	<div style="border: 1px solid black; padding: 5px;"> FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO </div>
2			MANHOLE	
3				
4				
5			WASH-LE	
6				
7			VAPOR	
8			VENT	
9			TO VACUUM EQUIPMENT	
10			REFLUX IN FROM	
11		1 1/2	FEED FROM	G A 9 C E
12			FEED FROM	
13			FEED FROM	
14			TO REBOILERS PUMP	
15			FROM REBOILER	
16			EQUALIZING LINE WITH	
17			BOTTOM OUTLET TO	
18	2		LIQUID OUTLET TO	G A 9 I I
19			DRAWOFF TO	
20			RETURN FROM	
21			RETURN FROM	
22			RETURN FROM	
23			DRAWOFF TO	
24			RETURN FROM	
25			REFLUX DRAHOFF TO	
26			REFLUX IN FROM	
27			REFLUX DRAHOFF TO	
28			REFLUX IN FROM	
29			PROCESS STEAM	
30			STEAM OUT (SO)	
31			DRAIN	
32			SAMPLE CONN. (SL COOLER (SC)	
33			SAFETY VALVE (SV)	
34			SAFETY VALVE (PSV) (PSV)	
35			UTILITY CONNECTION	
36			PRESSURE GAGE (PG)	
37			PRESSURE CONTROLLER (P)	
38			PRESSURE TAP (PT)	
39	1	1 1/2	No. 9 - Rising	
40			TEMPERATURE INDICATOR (TI)	
41			TEMPERATURE CONTROLLER (T)	
42			TEMPERATURE RECORDER (TR)	
43			TEMPERATURE WELL (TW)	
44	1	1	9846 - HALL	
45			GAUGE GLASS (GG)	
46			EXTERNAL LEVEL	
47			INTERNAL LEVEL	
48			LEVEL ALARM (LA)	
49	2	2	STEAM COIL	
50				



2) STEAM COIL TO MAINTAIN 60°F.

				THE LUMINUS COMPANY Rochester	
		TITLE JET FUEL PROTECT CLIENT AMOCO/DEL LOCATION EFULAH, ND PROJ NO JDS NO 05571			
					
	W/IN 19 FEB TASK 4				
REV	REVIS DATE	DESCRIPTION	PROJ DURA	PROJ DURA	APPR
					VESSEL NO FB-905 DWS SIG-

VESSEL NO. FB-906 COME WITH
 VESSEL NAME 24" JET FUEL TANK
 DIAMETER 24" - 0" H= 8' - 0"
 VERT HT 8' - 0" B-B BERTY
 HORN LENGTH
 OPER TEMP TOP 112 TOP 112 BOTY 112
 MAX TEMP TOP 112 TOP 112 BOTY 112
 NORM OPER PRESS 6 H₂O H₂O OR
 MAX OPER PRESS 6 H₂O H₂O OR
 CORROSION ALLOW SHELL IN DECKS

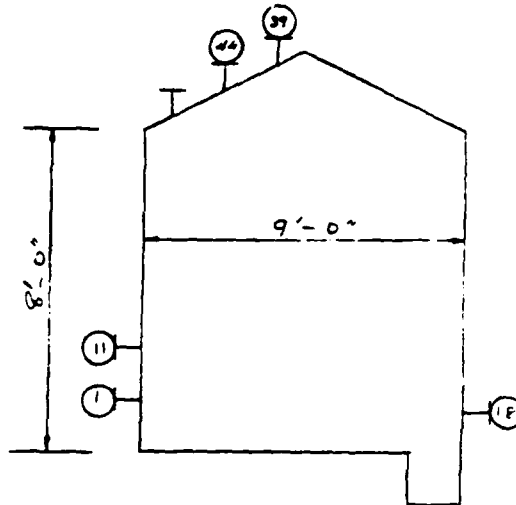
DES TEMP 230
 DES PRESS 6 H₂O H₂O VAC -2 H₂O
 HEADS ELIP DISHER COME 20" F PLAT 20" F
 CODE ASME AP X OTHER
 STRESS RELIEVED YES NO COR'
 RADIOGRAPHED YES NO DECA
 EARTHQUAKE SHND SHND

MATL. SHELL CS LINER THK IN
 INSULATION CONSERV X PROTECTN NONE
 DBOX MATL

NOZZLES: FLG CLASS _____ COUPL CLASS _____

ITEM NO	SIZE	SERVICE & SYMBOL
1	24	MANHOLE
2		MANHOLE
3		
4		
5		MANHOLE
6		
7		VAPOR OUTLET TO
8		VENT
9		TO VACUUM EQUIPMENT
10		REFLUX IN FROM
11		FEED FROM <u>GA-916</u>
12		FEED FROM
13		FEED FROM
14		TO REBOILER (REB PUMP)
15		FROM REBOILER
16		EQUALIZING LINE WITH
17		BOTTOM OUTLET TO
18		LIQUID OUTLET TO <u>GA-910</u>
19		DRAWOFF TO
20		RETURN FROM
21		DRAWOFF TO
22		RETURN FROM
23		DRAWOFF TO
24		RETURN FROM
25		REFLUX DRAWOFF TO
26		REFLUX IN FROM
27		REFLUX DRAWOFF TO
28		REFLUX IN FROM
29		PROCESS STEAM
30		STEAM OUT BCI
31		DRAIN
32		SAMPLE CONN. IN COOLER BCI
33		SAFETY VALVE (SV)
34		SAFETY VALVE (SV) (VSV)
35		UTILITY CONNECTION
36		PRESSURE GAGE (PG)
37		PRESSURE CONTROLLER P _____ Q
38		PRESSURE TAP (PT)
39		<u>HA BACKFLOW</u>
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (TC) _____ Q
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44		<u>GAUGE - MATL</u>
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49		
50		

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO



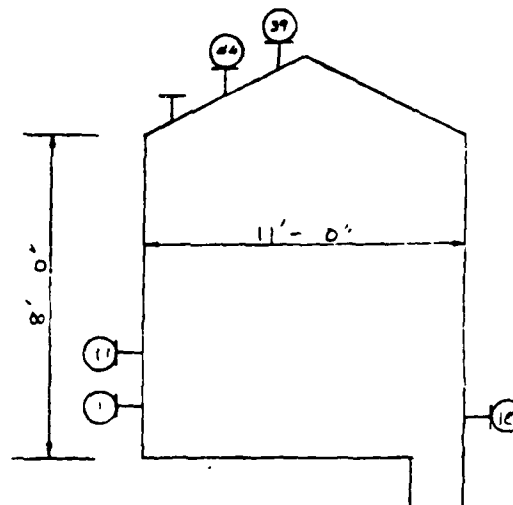
NOTE: LIQUID SP GR = 0.85 @ operating temp

		THE LUMMUS COMPANY	
		Beverly Hills, California	
TITLE JET FUEL PROJECT CLIENT AND/OR JOB - MPT LOCATION BEULAH, ND PLANT NO. 1 FROM NO. 1 JOB NO. 05771			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	DESIGNED CHECKED APPR APPR
VESSEL NO FB-906		SHEET NO -	

VESSEL NO FB-907 COGS WITH _____
 VESSEL NAME NIKE-X-100 DAY TANK
 DIAMETER 11'-0" S.D. 8
 VERT HT 8'-0" T.D. 8000
 NOSE LENGTH _____
 OPER TEMP TOP _____ ° BOTM _____ ° BRUM 115 °
 MAX TEMP TOP _____ ° BOTM _____ ° BRUM _____ °
 NORM OPER PRESS 5" H₂O PSY OR _____
 MAX OPER PRESS _____ PSY OR _____
 CORROSION ALLOW SHELL _____ IN DISCS _____
 DES TEMP 220 °
 DES PRESS 5" H₂O DES VAC -2" H₂O
 HEADS SLIP _____ DISHED _____
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVER YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____
 MATL SHELL CS LINER _____ THE _____
 INSULATION CONSERVATION X PROTECTIN _____
 DECK MATL _____
 NOZZLES FLG CLASS _____ COUPL CLASS _____

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1	1	2"	MANHOLE
2			MANHOLE
3			
4			
5			MANHOLE
6			
7			VAPOR OUTLET TO _____
8			VENT
9			TO VACUUM EQUIPMENT
10			REFILL IN FROM _____
11			FEED FROM <u>GA-915</u>
12			FEED FROM _____
13			FEED FROM _____
14			TO (REBOILER) (RES. PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH _____
17			BOTTOM OUTLET TO _____
18			LIQUID OUTLET TO <u>GA-909</u>
19			DRAWOFF TO _____
20			RETURN FROM _____
21			DRAWOFF TO _____
22			RETURN FROM _____
23			DRAWOFF TO _____
24			RETURN FROM _____
25			REFLUX DRAINOFF TO _____
26			REFLUX IN FROM _____
27			REFLUX DRAINOFF TO _____
28			REFLUX IN FROM _____
29			PROCESS STEAM
30			STEAM OUT (SC)
31			DRAIN
32			SAMPLE COOL. BL. COOLER (SC)
33			SAFETY VALVE (SV)
34			SAFETY VALVE (SV) (SV)
35			UTILITY CONNECTION
36			PRESSURE GAUGE (PG)
37			PRESSURE CONTROLLER P _____
38			PRESSURE TAP (PT)
39			<u>NO AUTOMATING</u>
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T) _____
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			<u>SAFETY - HALL</u>
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

PLANNED NOZZLES ARE
 SUPPLIED 1/8"
 FOR COUPLING ADD
 50 TO NOZZLE NO.



NOTES: LSG SPGR = 0.96 @ operating temp

		THE LUMMUS COMPANY Houston	
TITLE <u>JET FUEL PROTECT</u>			
CLIENT AND/OR DESIG. LOCATION <u>BEULAH, ND</u>			
DRAWING SHEET NO. <u>06571</u>			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	APPV
1	11/14/55	FOR TANK 4	XL
VESSEL NO <u>FB-907</u>		DESIG. NO. <u>-</u>	

VESSEL NO. FG-908 COME WITH
 VESSEL NAME ACRYLIC TOPPING FEED MONITOR STORAGE
 DIAMETER 24'-0" R-8 8
 VERT HT 24'-0" R-8 8
 HORZ LENGTH _____
 OPER TEMP: TOP _____ ° BOTM _____ ° DRUM 100 °
 MAX TEMP: TOP _____ ° BOTM _____ ° DRUM 113 °
 NORM OPER PRESS _____ PSIG OR _____
 MAX OPER PRESS 6 H₂O PSIG OR _____
 CORROSION ALLOW SHELL 2" R-8 8 DECK _____

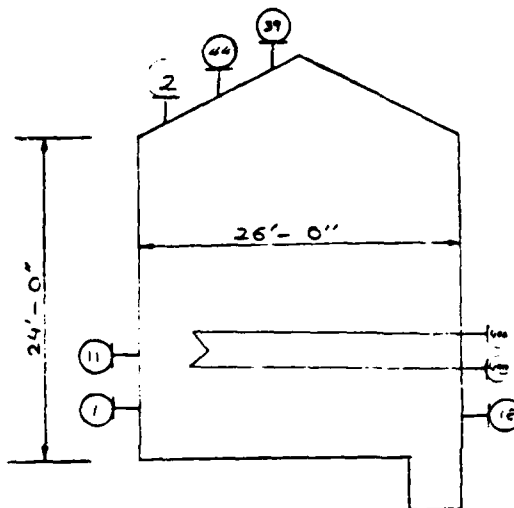
DES TEMP 220 °
 DES PRESS 6 H₂O PSIG VAC -2" H₂O
 HEADS ELIP _____ DISHD _____ CONE ROCE FLAT BOTTOM
 CODE ARME _____ API X OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____

MATL SHELL CS LINER _____ THK _____
 INSULATION CONSERVYN X PROTECTN _____ NONE
 DECK MATL _____

NOZZLES: PLS CLASS _____ COUP CLASS _____

ITEM NO	SIZE	SERVICE & SYMBOL
1	24	MANHOLE (SH-FLC)
2	24	MANHOLE (2 DOG)
3		
4		
5		MANHOLE
6		
7		VAPOR OUTLET TO _____
8		VENT _____
9		TO VACUUM EQUIPMENT _____
10		REFLUX IN FROM _____
11	2	FEED FROM <u>GA-908</u>
12		FEED FROM _____
13		FEED FROM _____
14		TO REBOILER (RES PUMP) _____
15		FROM REBOILER _____
16		EQUALIZING LINE WITH _____
17		BOTTOM OUTLET TO _____
18	2	LIQUID OUTLET TO <u>GA-917</u>
19		DRAFF TO _____
20		RETURN FROM _____
21		DRAFF TO _____
22		RETURN FROM _____
23		DRAFF TO _____
24		RETURN FROM _____
25		REFLUX DRAFF TO _____
26		REFLUX IN FROM _____
27		REFLUX DRAFF TO _____
28		REFLUX IN FROM _____
29		PROCESS STEAM _____
30		STEAM OUT (SO) _____
31		DRAIN _____
32		SAMPLE CONN (EL COOLER (SC) _____
33		SAFETY VALVE (PSV) _____
34		SAFETY VALVE (PSV) (MSV) _____
35		UTILITY CONNECTION _____
36		PRESSURE GAGE (PG) _____
37		PRESSURE CONTROLLER (P) _____
38		PRESSURE TAP (PT) _____
39	1/2	<u>N₂ G-ANALYSIS</u>
40		TEMPERATURE INDICATOR (TI) _____
41		TEMPERATURE CONTROLLER (T) _____
42		TEMPERATURE RECORDER (TR) _____
43		TEMPERATURE WELL (TW) _____
44	1	<u>GAUGE - MAIN</u>
45		GAUGE GLASS (LG) _____
46		EXTERNAL LEVEL _____
47		INTERNAL LEVEL _____
48	2	LEVEL ALARM (LA) _____
49	4	STEAM COIL
50		

FLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO.



NOTE: 1. 50% = G₁ = 104 @ operating temp.

2) STEAM COIL TO MAINTAIN 100°F TEMP

		THE LUMBER COMPANY Houston	
TITLE <u>JET FUEL PROTECT</u>			
CLIENT <u>AMCO/DOE</u>		LOCATION <u>BRULAH, ND</u>	
PROJ NO		DES NO <u>05371</u>	
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	DESIGNED DRAWN APPR APPR
VESSEL NO <u>FG-908</u>		DES NO -	

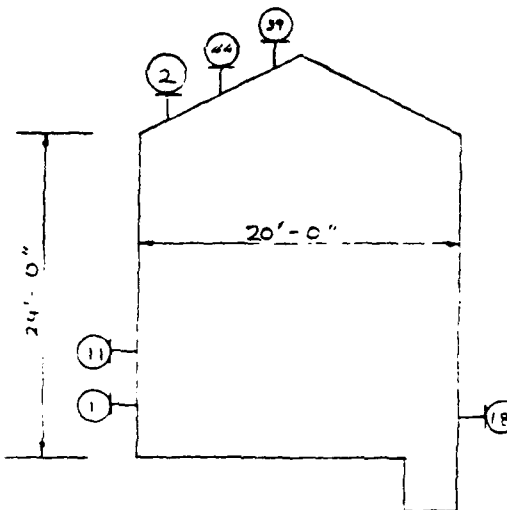
VESSEL NO. FE 909 COMB WITH
 VESSEL NAME XY-2ND INTERMEDIATE MONTH STORAGE
 DIAMETER 20" R-H
 VERT HT 24'-0" R-H BURT
 HORIZ LENGTH R-H
 OPER TEMP TOP ° BOTM ° DRUM AMB °
 MAX TEMP TOP ° BOTM ° DRUM 113 °
 NORM OPER PRESS PSIG OR BAR
 MAX OPER PRESS 5 H₂O PSIG OR BAR
 CORROSION ALLOW SHELL IN DECKS IN

DES TEMP 230 °
 DES PRESS 8" H₂O PSIG VAC -2" H₂O PSIG
 HEADS ELIP DISHED CONE ROOF FLAT BOTTOM
 CODE ASME AM X OTHER
 STRESS RELIEVED YES CODE
 RADIOGRAPHED YES CODE
 EARTHQUAKE WIND RUSH

MATL SHELL CS LINER THK IN
 INSULATION CONSERV X PROTECTN NONE
 DECK MATL

NOZZLES FLG CLASS COUP CLASS

ITEM NO	SIZE	SERVICE & SYMBOL
1	24"	MANHOLE (H-FULL)
2	24"	MANHOLE (H-FULL)
3		FLANGED NOZZLES ARE NUMBERED 1-80 FOR COUPLING ADD 80 TO NOZZLE NO
4		
5		MANHOLE
6		
7		VAPOR OUTLET TO
8		VENT
9		TO VACUUM EQUIPMENT
10		REFLUX IN FROM
11	2"	FEED FROM GA-912
12		FEED FROM
13		FEED FROM
14		TO REBOILER: REB PUMP
15		FROM REBOILER
16		EQUALIZING LINE WITH
17		BOTTOM OUTLET TO
18	2"	LIQUID OUTLET TO GA-912
19		DRAWOFF
20		REFLUX IN
21		DRAWOFF
22		RETURN FROM
23		DRAWOFF
24		RETURN FROM
25		REFLUX DRAWOFF TO
26		REFLUX IN FROM
27		REFLUX DRAWOFF TO
28		REFLUX IN FROM
29		PROCESS STEAM
30		STEAM OUT (SO)
31		DRAIN
32		SAMPLE DOWN (SL COOLER (SC)
33		SAFETY VALVE (PSV)
34		SAFETY VALVE (PSV) (DSV)
35		UTILITY CONNECTION
36		PRESSURE GAUGE (PG)
37		PRESSURE CONTROLLER (P) <u> </u> C
38		PRESSURE TAP (PT)
39	1/4"	TEMP. INDICATOR (TI) <u> </u> C
40		TEMPERATURE CONTROLLER (TC) <u> </u> C
41		TEMPERATURE RECORDER (TR)
42		TEMPERATURE WELL (TW)
43		TEMP. ALARM (AL)
44	1"	GAUGE GLASS (GG)
45		EXTERNAL LEVEL
46		INTERNAL LEVEL
47		LEVEL ALARM (AL)
48		
49		
50		



NOTES LIQUID SP GR = 0.96 @ operating temp.

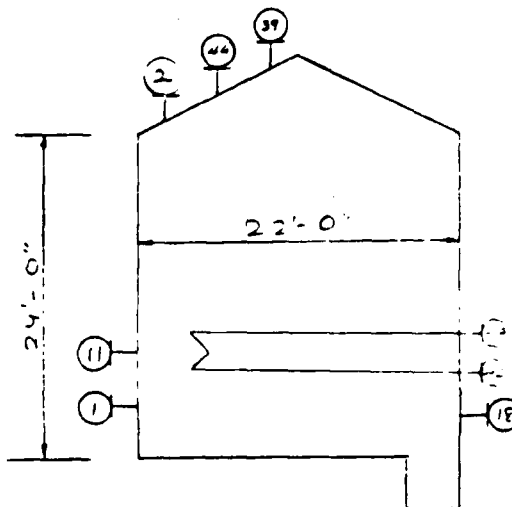
										THE LUMMUS COMPANY Houston	
										TITLE JET FUEL PROTECT CLIENT AMCO/DOE LOCATION SEULAH, ND PROJ NO JOB NO 05571	
PROCESS VESSEL SKETCH											
REV	DATE	DESIGN PT.	PROJ. ENGINEER	PROJ. MANAGER	APPROV.	APPROV.	VESSEL NO FE-909		DWG NO 		

VESSEL NO. FR-910 COMB WITH _____
 VESSEL NAME 2" H₂O F-21 2" H₂O F-21
 DIAMETER 24" O.D. 24" O.D. 24" O.D.
 VENT HT 24" O.D. 24" O.D. 24" O.D.
 HORIZ LENGTH _____
 OPER TEMP TOP _____ °F BOTM _____ °F DRUM 150 °F
 MAX TEMP TOP _____ °F BOTM _____ °F DRUM _____ °F
 NORM OPER PRESS _____ PSI OR _____
 MAX OPER PRESS _____ PSI OR _____
 CORROSION ALLOW SHELL _____ DECK _____
 DES TEMP 220 °F
 DES PRESS _____ VAC 2" H₂O
 HEADS ELIP _____ DISHED _____ CONE _____ FLAT _____
 CODE ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____
 MATL SHELL CS CS CS
 INSULATION CONSERV X PROTECT _____ NONE _____
 DECK MATL _____

NOZZLES FLO CLASS _____ COUPL CLASS _____

ITEM NO	SIZE	SERVICE & SYMBOL
1	24	MANHOLE
2	24	MANHOLE
3		
4		MANHOLE
5		
6		
7		VAPOR OUTLET TO
8		VENT
9		TO VACUUM EQUIPMENT
10		REFLUX IN FROM
11		FEED FROM <u>FR-912</u>
12		FEED FROM
13		FEED FROM
14		TO REBOILER (REB PUMP)
15		FROM REBOILER
16		EQUALIZING LINE WITH
17		BOTTOM OUTLET TO
18		LIQUID OUTLET TO <u>FR-912</u>
19		DRAWOFF TO
20		RETURN FROM
21		DRAWOFF TO
22		RETURN FROM
23		DRAWOFF TO
24		RETURN FROM
25		REFLUX DRAWOFF TO
26		REFLUX IN FROM
27		REFLUX DRAWOFF TO
28		REFLUX IN FROM
29		PROCESS STEAM
30		STEAM OUT (SO)
31		DRAIN
32		SAMPLE COHN (SL COOLER (SC)
33		SAFETY VALVE (SV)
34		SAFETY VALVE (PSV) (VSV)
35		UTILITY CONNECTION
36		PRESSURE GAGE (PG)
37		PRESSURE CONTROLLER (PC) _____ G
38		PRESSURE TAP (PT)
39	1/2"	<u>2" H₂O F-21</u>
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (TC) _____ G
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44	1"	<u>2" H₂O F-21</u>
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49	1"	<u>STEAM COIL</u>
50		

FLANGED NOZZLES ARE
NUMBERED 1-50
FOR COUPLING ADD
80 TO NOZZLE NO



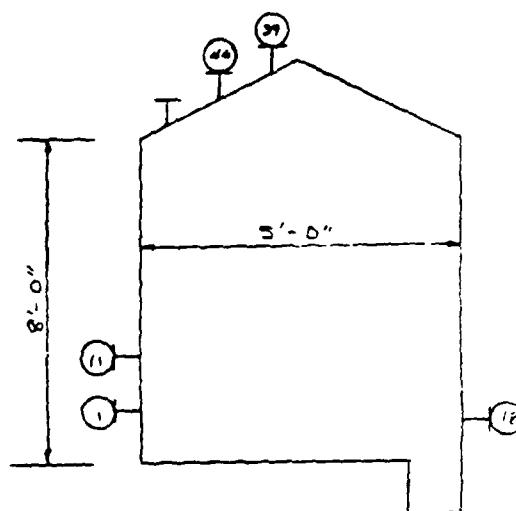
NOTES: 1. 1/2" GAGE SP GR = 103 @ operating temp.
 2. STEAM COIL TO MAINTAIN 100°F

		THE LUMMUS COMPANY Birmingham	
TITLE: <u>JET FUEL PROTECT</u>			
CLIENT: <u>AMOCO/DOL</u>		LOCATION: <u>REULAH, ND</u>	
PROJECT: <u>PLASMA SPARK</u>		JOB NO: <u>05571</u>	
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	DESIGNED DRAWN APPROVED CHECKED
1	11/11/77	FOR TALK 4	DESIGNED DRAWN APPROVED CHECKED
VESSEL NO <u>FR-910</u>		DWG NO <u>05571</u>	

VESSEL NO FB-911 COME WITH _____
 VESSEL NAME SLICE CUT MONTH STORAGE
 DIAMETER 5'-0" IN 8 IN 8 IN 8 IN
 VENT HT 8'-0" IN 8 IN 8 IN 8 IN
 NOZZLE LENGTH _____
 OPER TEMP TOP _____ ° F BOTT _____ ° F BREAN AM ° F
 MAX TEMP TOP _____ ° F BOTT _____ ° F BREAN 112 ° F
 NORM OPER PRESS _____ PSI OR _____
 MAX OPER PRESS 6" H₂O PSI OR _____
 CORROSION ALLOW: SHELL _____ IN SEEDS _____ IN
 DES TEMP 230 ° F
 DES PRESS 2" H₂O IN 2" H₂O IN
 HEADS: SLIP _____ BUSHED _____ OTHER EDGE PLAT BOTTOM
 CODE: ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE YES _____ CODE _____
 MATL: SHELL CS LINER _____ INS _____
 INSULATION CONSERVATION _____ PROTECTIVE _____
 DECK MATL _____
 NOZZLES: FLS CLASS _____ COUPL CLASS _____

ITEM NO.	NO.	SIZE IN	SERVICE & SYMBOL
1	1	2	MANHOLE
2			MANHOLE
3			
4			
5			MANHOLE
6			
7			VAPOR OUTLET TO _____
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLEX IN FROM _____
11			FEED FROM <u>GA-903</u>
12			FEED FROM _____
13			FEED FROM _____
14			TO REBOILER (FEED PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH _____
17			BOTTOM OUTLET TO _____
18			LIQUID OUTLET TO <u>PUMP</u>
19			DRAWOFF TO _____
20			RETURN FROM _____
21			DRAWOFF TO _____
22			RETURN FROM _____
23			DRAWOFF TO _____
24			RETURN FROM _____
25			REFLEX DRAFFOFF TO _____
26			REFLEX IN FROM _____
27			REFLEX DRAFFOFF TO _____
28			REFLEX IN FROM _____
29			PROCESS STEAM
30			STEAM OUT BCI
31			DRAIN
32			SAMPLE CONN. TO COOLER (SC)
33			SAFETY ALIVE (SV)
34			SAFETY VALVE (SV) (V)
35			UTILITY CONNECTION
36			PRESSURE GAUGE (PG)
37			PRESSURE CONTROLLER P _____ Q
38			PRESSURE TAP (PT)
39			<u>SA-24296/249</u>
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T) _____ Q
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			<u>SAFETY MATL</u>
45			GAUGE GLASS (GG)
46			INTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE
 SUBSIZED 1/80
 FOR COUPLING ADD
 50 TO NOZZLE NO



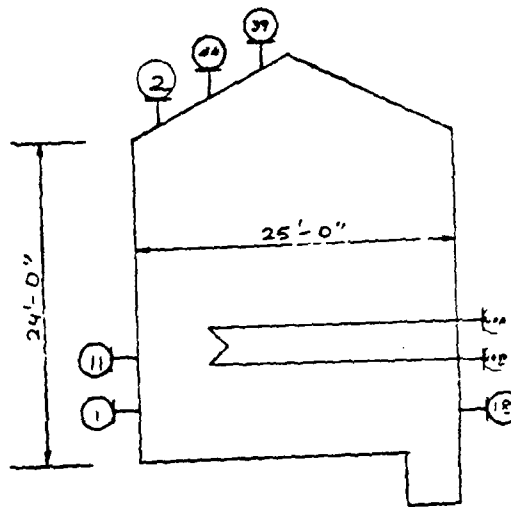
NOTES: 1. 1/80 SP GR = 1.006 at operating temp

		THE LUMMUS COMPANY Houston, Texas	
WITH JET FUEL PROTECT BLAST AMSCO/DSE LOCATION OF ULAN, ND FROM NO _____ DES NO 05571			
PROCESS VESSEL SKETCH			
REV	DATE	DESCRIPTION	VESSEL NO <u>FB-911</u> DES NO <u>-</u>
1	1/14/83	FOR TMS 4	

VESSEL NO. FB-912 COMB WITH _____
 VESSEL NAME M/J-CRACKER PROCESS MAGNA STORAGE
 DIAMETER 25'-0" S.D. 1 S.D.
 VERT HT 24'-0" S.D. 1 S.D.
 NOZZLE LENGTH _____
 OPER TEMP: TOP _____ ° BOY _____ ° SEAL 50 °
 MAX TEMP: TOP _____ ° BOY _____ ° SEAL 113 °
 NORM OPER PRESS _____ PSI OR _____
 MAX OPER PRESS 6 H₂O _____ PSI
 CORROSION ALLOW: SHELL 1/8" S.D. _____
 DES TEMP 220 °
 DES PRESS 6 H₂O _____ PSI
 HEADS: SLP _____ S.D. _____ COME ROOF PLAT BOTTOM
 CODE: ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 SCAFFOLDING: YES _____ NO _____
 MATL: SHELL CS LINER _____
 INSULATION: CONSERV _____ PROTECT _____
 BACK MATL: _____
 NOZZLES: PLS CLASS _____ COUPL CLASS _____

ITEM NO.	NO.	SIZE	SERVICE & SYMBOL
1	1	24	MANHOLE
2	2	20	MANHOLE
3			
4			MANHOLE
5			
6			
7			VAPOUR OUTLET TO
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11	1	2	FEED FROM <u>GA-01</u>
12			FEED FROM
13			FEED FROM
14			TO REBOILER (FEED PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH
17			BOTTOM OUTLET TO <u>PUMP</u>
18	1	2	LIQUID OUTLET TO
19			DRAWOFF TO
20			RETURN FROM
21			DRAWOFF TO
22			RETURN FROM
23			DRAWOFF TO
24			RETURN FROM
25			REFLUX DRAWOFF TO
26			REFLUX IN FROM
27			REFLUX DRAWOFF TO
28			REFLUX IN FROM
29			PROCESS STEAM
30			STEAM OUT (S)
31			DRAIN
32			SAMPLE COCK (S) COOLER (S)
33			SAFETY VALVE (S)
34			SAFETY VALVE (S) (S)
35			UTILITY CONNECTION
36			PRESSURE GAUGE (S)
37			PRESSURE CONTROLLER P _____
38			PRESSURE TAP (S)
39	1	1/2	<u>NO ALARMING</u>
40			TEMPERATURE INDICATOR (T)
41			TEMPERATURE CONTROLLER (T) _____
42			TEMPERATURE RECORDER (T)
43			TEMPERATURE WELD (TW)
44	1	1/2	<u>GAUGE - 20 PSI</u>
45			GAUGE GLASS (S)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48	2	1/2	<u>LEVEL ALARM (S)</u>
49			<u>STEAM COIL</u>

PLANNED NOZZLES ARE
 MARKED HSL
 FOR COUPLING ADD
 50 TO NOZZLE NO



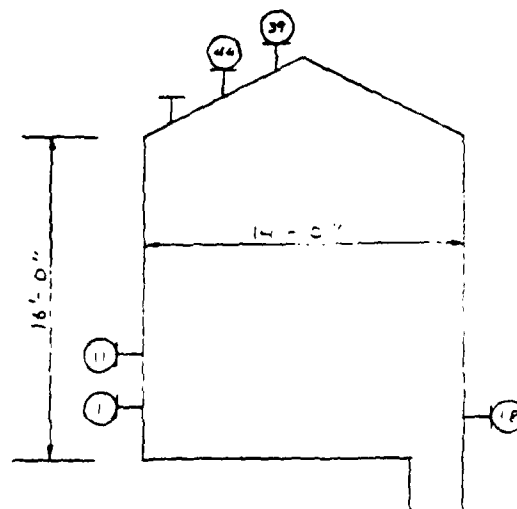
NOTES: 1) LIQUID SP GR = 1.02 @ operating temp.
 2) STEAM COIL TO MAINTAIN 60°F TEMP MIN

		E. I. du Pont de Nemours and Company Corporation	
WITH JET FUEL PROTECT GASTANK/DOL LOCATION 22ULAH, ND PHONE 05571			
PROCESS VESSEL SKETCH			
VESSEL NO FB-912	SHEET NO -		

VESSEL NO FB-913 COMB WITH _____
 VESSEL NAME Jet Fuel Project _____
 DIAMETER 14'-0" _____
 VENT HT 14'-0" _____
 NOZZLE LENGTH _____
 OPER TEMP TOP _____ BOTM _____ DRUM 113 _____
 MAX TEMP TOP _____ BOTM _____ DRUM 113 _____
 NORM OPER PRESS _____ PSI OR _____
 MAX OPER PRESS _____ PSI OR _____
 CORROSION ALLOW: SHELL _____ IN DECK _____
 DES TEMP 230 _____
 DES PRESS 5.5 _____ HIG VAC -2" Hg _____
 HEADS: S.P. _____ SHIPED _____ CODE ES-2 PLAT 2.5 _____
 CODE: ASME _____ API _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 BARTOLAME _____ WND _____
 MATL: SHELL CS LINER _____
 INSULATION CONSERVATION X PROTECTIVE _____
 DECK MATL: _____

ITEM NO	NO	SIZE	SERVICE & SYMBOL
1	1	2"	MANHOLE
2			MANHOLE
3			
4			
5			MANHOLE
6			
7			VAPOR OUTLET TO
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11	1	1/2"	FEED FROM <u>GA-910</u>
12			FEED FROM
13			FEED FROM
14			TO REBOILER (REB. PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH
17			BOTTOM OUTLET TO
18	1	2"	<u>PUMP</u>
19			RETURN FROM
20			DRAWOFF TO
21			RETURN FROM
22			DRAWOFF TO
23			RETURN FROM
24			DRAWOFF TO
25			REFLUX DRAWOFF TO
26			REFLUX IN FROM
27			REFLUX DRAWOFF TO
28			REFLUX IN FROM
29			PROCESS STEAM
30			STEAM OUT (SC)
31			DRAIN
32			SAMPLE DOWN (SL. COOLER (SC))
33			SAFETY VALVE (SV)
34			SAFETY VALVE (SV) (NRY)
35			UTILITY CONNECTION
36			PRESSURE GAUGE (PG)
37			PRESSURE CONTROLLER P. _____ Q
38			PRESSURE TAP (PT)
39	1	1/2"	<u>GA-910</u>
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (TC) _____ Q
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELD (TW)
44	1	1"	<u>GAUGE</u>
45			GAUGE GLASS (GG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

PLANNED NOZZLES ARE
 SHOWN 1-1/2"
 FOR COUPLING ADD
 1/2" TO NOZZLE NO



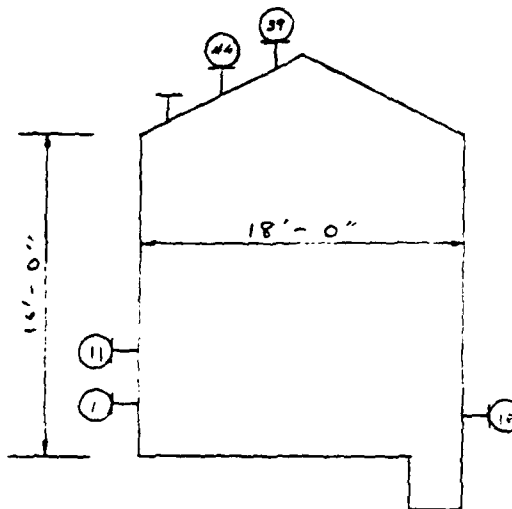
NOTES: L1032 SP GR = 0.96 @ operating temp.

		THE LUMMUS COMPANY Houston	
TITLE JET FUEL PROJECT		LOCATION BEULAH, ND	
CLIENT AMCO/DOE		JOB NO 05571	
PROCESS VESSEL SKETCH			
REV DATE	DESCRIPTION	PROJ. ENG. DESIGNED	PROJ. ENG. CHECKED
VESSEL NO FB-913		DES. NO. -	

VESSEL NO FB-914 COMB WITH _____
 VESSEL NAME HYDROLYSIS M.P. ST-10-GE
 DIAMETER 18'-0" IN. & _____ IN.
 VERT HT 12'-0" IN. & _____ IN.
 HORZ LENGTH _____ IN.
 OPER TEMP TOP _____ °F BOTM _____ °F DRUM AMP _____ °F
 MAX TEMP TOP _____ °F BOTM _____ °F DRUM JLT _____ °F
 NORM OPER PRESS _____ PSIG OR _____ PSIA
 MAX OPER PRESS _____ PSIG OR _____ PSIA
 CORROSION ALLOW SHELL _____ DECK _____ IN.
 DES TEMP 220 °F
 DES PRESS 8.12 LBS VAC -2 H₂O PSIA
 HEADS ELIP _____ DISHED _____ CONE _____ FLAT _____ PCY TEM _____
 CODE ARME _____ AP _____ X _____ OTHER _____
 STRESS RELIEVED YES _____ CODE _____
 RADIOGRAPHED YES _____ CODE _____
 EARTHQUAKE _____ WIND _____ PSIA
 MATL SHELL CS LINER _____ THK _____ IN.
 INSULATION CONSERV _____ X PROTECT N _____ NONE _____
 DECK MATL _____
 NOZZLES PLS CLASS _____ COUPL CLASS _____

ITEM NO	SIZE	SERVICE & SYMBOL
1	24	MANHOLE
2		MANHOLE
3		
4		
5		MANHOLE
6		
7		VAPOR OUTLET TO _____
8		VENT
9		TO VACUUM EQUIPMENT
10		REFLUX IN FROM _____
11	2	FEED FROM <u>GT-909</u>
12		FEED FROM _____
13		FEED FROM _____
14		TO REBOILER (RES PUMP)
15		FROM REBOILER
16		EQUALIZING LINE WITH _____
17		BOTTOM OUTLET TO _____
18	2	LIQUID OUTLET TO <u>P.M.P.</u>
19		DRAWOFF TO _____
20		RETURN FROM _____
21		DRAWOFF TO _____
22		RETURN FROM _____
23		DRAWOFF TO _____
24		RETURN FROM _____
25		REFLUX DRAWOFF TO _____
26		REFLUX IN FROM _____
27		REFLUX DRAWOFF TO _____
28		REFLUX IN FROM _____
29		PROCESS STEAM
30		STEAM OUT BOI
31		DRAIN
32		SAMPLE DOWN BL COOLER (BO)
33		SAFETY VALVE (PSV)
34		SAFETY VALVE (PSV) (MSV)
35		UTILITY CONNECTION
36		PRESSURE GAUGE (PG)
37		PRESSURE CONTROLLER (P) _____ C
38		PRESSURE TAP (PT)
39	1/4	AS GATHERING
40		TEMPERATURE INDICATOR (TI)
41		TEMPERATURE CONTROLLER (T) _____ C
42		TEMPERATURE RECORDER (TR)
43		TEMPERATURE WELL (TW)
44	1	GAUGE - MATL
45		GAUGE GLASS (GG)
46		EXTERNAL LEVEL
47		INTERNAL LEVEL
48		LEVEL ALARM (LA)
49		
50		

PLANGED NOZZLES ARE
 NUMBERED 1-50
 FOR COUPLING ADD
 50 TO NOZZLE NO



NOTES LIG 24 GR 20 PS @ operating temp.

		THE LUMMUS COMPANY Houston, Texas	
TITLE <u>JET FOPL PROJECT</u>			
CLIENT <u>AM OGD/DOE</u>		LOCATION <u>SPULAW, ND</u>	
PROJ NO _____		JOB NO <u>06571</u>	
PROCESS VESSEL SKETCH			
REV _____ DATE _____	DESCRIPTION _____	CHECKED _____ DATE _____	APPN _____ DATE _____
VESSEL NO <u>FB-914</u>		DRG NO - _____	



THE LUMMUS COMPANY
Bloomfield

Always refer to this number

Div. Job PO/Req. Sup.

DATA SHEET - LIQUID RING VACUUM PUMP

1	APPLICABLE TO	<input type="radio"/> PROPOSAL	<input type="radio"/> PURCHASE	<input type="radio"/> AS BUILT	ITEM NO.	GB 901A25		
2	FOR AMOCO/DGE - JET FUEL PROJECT				UNIT			
3	SITE				DRIVER	3		
4	SERVICE VACUUM PUMP FOR 900 AREA				NO. REQUIRED	1		
5	MANUFACTURER	MODEL			SERIAL NO.			
6	NOTE	<input type="radio"/> INDICATES INFORMATION TO BE COMPLETED BY PURCHASER				<input type="checkbox"/> BY MANUFACTURER		
7								
8	OPERATING CONDITIONS							
9	(ALL DATA ON PER UNIT BASIS)				OTHER CONDITIONS			
10		NORMAL	RATED	A	B	C	RUN-IN	
11	<input type="radio"/> GAS HANDLED (Also See Page 2 of 5)		AIR					
12	<input type="radio"/> MMSCFD/SCFM (14.7 psia & 60°F dry)							
13	<input type="radio"/> WEIGHT FLOW (lb/min) - (Wet) - (Dry)		3.5					
14	INLET CONDITIONS:							
15	<input type="radio"/> PRESSURE (psia) *		1.9					
16	<input type="radio"/> TEMPERATURE (°F)		265					
17	<input type="radio"/> RELATIVE HUMIDITY (%)							
18	<input type="radio"/> MOLECULAR WEIGHT (M)		29					
19	<input type="checkbox"/> n_g (Path Exponent, PTC-10) C_F/C_V		1.29					
20	<input type="checkbox"/> COMPRESSIBILITY (Z1) OR (Zavg)		1.0					
21	<input type="checkbox"/> INLET VOLUME, (cfm-WET) *		494					
22	DISCHARGE CONDITIONS:							
23	<input type="radio"/> PRESSURE (psia) *		22.1					
24	<input type="checkbox"/> TEMPERATURE (°F)							
25	<input type="checkbox"/> n_g (Path Exponent, PTC-10)							
26	<input type="checkbox"/> COMPRESSIBILITY (Z2) OR (Zavg)		1.0					
27								
28	<input type="checkbox"/> bhp REQUIRED (All Losses Incl.)							
29	<input type="checkbox"/> SPEED (rpm)							
30	<input type="checkbox"/> PRESSURE RATIO (R)							
31	<input type="checkbox"/> VOLUMETRIC EFFICIENCY (%)							
32	<input type="checkbox"/> SILENCER ΔP (psi) INLET/DISCHARGE	/	/	/	/	/	/	
33	<input type="checkbox"/> PERFORMANCE CURVE NO.							
34	PROCESS CONTROL:							
35	METHOD	<input type="radio"/> BYPASS FROM		TO	<input type="radio"/> BYPASS <input type="radio"/> MANUAL <input type="radio"/> AUTO			
36		<input type="radio"/> SPEED VARIATION FROM		TO				
37		<input type="radio"/> OTHER						
38	SIGNAL	<input type="radio"/> SOURCE						
39		<input type="radio"/> TYPE						
40		<input type="radio"/> RANGE FOR PNEUMATIC CONTROL		rpm AT	psig AND	rpm AT	psig	
41	OTHER							
42								
43								
44								
45								
46								
47								
48								
49								
50	AT CUSTOMER CONNECTIONS TO SILENCERS							
51	Prepared:	Approved:	Date: 4/14/79	Rev. Δ	Rev. Δ	Rev. Δ		

A109 04 0783-TP2 5.1/1 REV 4

JOB _____ ACCT. 05571 _____



LCI PROJECT 5571
TASK 4.0

6.0 EQUIPMENT DATA AND ESTIMATE SHEETS

6.4 Offsites - AREA 400

RR5571-6.TXT

OSBL ESTIMATE

PIPING

<u>600 TONS X 1.1 FOR FITTINGS & FLANGES X \$200/TON</u>	\$1,320,000
<u>2000 GALV. @ \$25/FT</u>	\$50,000
<u>LABOR @ .6 HRS/FT. X \$55/HR (80000 FT)</u>	\$2,640,000
<u>TRACING 16200 LF @ \$20/FT</u>	\$324,000

INSULATION

<u>FROM BACK UP</u>	\$420,000
---------------------	-----------

PIPERACK

<u>3000LF @ \$300/FT</u>	\$900,000
<u>CONCRETE 1500 Y3 X \$350/</u>	\$525,000

<u>TOTAL INTERCONNECTIONS</u>	\$6,179,000
-------------------------------	-------------

<u>EQUIPMENT</u>	\$1,846,000
------------------	-------------

<u>INSTALLATION MATERIALS FOR EQUIPMENT @ 25%</u>	\$461,500
---	-----------

<u>LABOR FOR EQUIPMENT & MATERIALS</u>	\$461,500
--	-----------

<u>S/T</u>	\$8,948,000
------------	-------------

<u>ENGINEERING @ 10 %</u>	\$900,000
---------------------------	-----------

<u>S/T</u>	\$9,848,000
------------	-------------

<u>CONTINGENCY @ 30%</u>	\$2,954,400
--------------------------	-------------

<u>TOTAL</u>	\$12,802,400
--------------	--------------

PIPE ABOVE GROUND

1 1/2	35000 LF	3.6 #/FT	126,000 #	5
2	11,000	5.0	55,000	
3	15,000	7.5	112,500	
4	7000	11.0	77,000	
8	1000	28.0	28,000	
20	2000	78.0	156,000	
30	2000	118.0	236,000	

PIPE BELOW GROUND

6	1700	19	32,300
10	2000	40	80,000
15	1500	50	75,000
26	1500	153	229,500

572

WEIGHT TOTAL

1,207,300 PIPE ONLY

INSULATION	1 1/2"	17,000 FT	\$ 10/FT	\$ 170,000
	2"	6000	12	72,000
	3"	8000	13	104,000
	4"	4000	14	56,000
	8"	1000	18	18,000
				<u>\$420,000</u>

AMLCU/DUE

5571

3/13/89

E.S.

OFFSITES SUMMARY

AREA 400

TASK 4 DESIGN

FB ITEMS ATTACHED

GA ITEMS ATTACHED

NEW RACK 800' 10 FT WIDE DOUBLE TIER
2200' 10 FT WIDE DOUBLE TIER

PIPING

INSUL.

AZA- 150" C.S.

LEX 150" GALV.

1 1/2" 35,000 FT

7000 FT

2" - 1000 FT

2" 11,000 FT

6000 FT

3" - 1000 FT

3" 15,000 FT

3000 FT

4" 7,000 FT

4000 FT

8" 1000 FT

1000 FT

20" 2000 FT (BURIED 9')

30" 2000 FT (STM TRACED) 2000 FT

SEWERS

ELECTRICAL TRUNK

26" T4S - BURIED 9'

1700 FT

2" 7000 FT

15" T5S - BURIED 9'

1500 FT

3" 2600 FT

6" T6S - BURIED 9'

1500 FT

3" 4300 FT

10" T5N - BURIED 9'

2000 FT

4" 2300 FT

1000

400 AREA

LUMMUS		ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST								
		REQ	EA			UNIT	TOTAL								
1	FB 401 JP-8 PRODUCT	1													
2	85' ID 40' TT TK														
3	mm														
4	MAT C.S. CLAD LING CA 1/8			8								304000			
5	DES PRESS +5"-2" WG														
6	DES PRESS														
7	CAPACITY: 38000 BARRELS														
8	INTERNAL														
9	TYPE: CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>														
10	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input checked="" type="checkbox"/>														
11	FB 402 STABILIZED NAPHTHA	1													
12	45' ID 40' TT TK														
13	mm			10								120000			
14	MAT C.S. CLAD LING CA 1/8														
15	DES PRESS +5"-2" WG														
16	DES PRESS														
17	CAPACITY: 12000 BARRELS														
18	INTERNAL														
19	TYPE: CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>														
20	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input checked="" type="checkbox"/>														
21	FB 403 FUEL OIL														
22	95' ID 48' TT TK	1													
23	mm														
24	MAT C.S. CLAD LING CA 1/8			8								472000			
25	DES PRESS +5"-2" WG														
26	DES PRESS														
27	CAPACITY: 59000 BARRELS														
28	INTERNAL HEATING COIL														
29	TYPE: CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>														
30	INSUL <input checked="" type="checkbox"/> API <input type="checkbox"/> BULLET <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input checked="" type="checkbox"/>														
TOTAL THIS PAGE		3													
TOTAL ACCOUNT															
CLIENT HROCO/DUE GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. M.H.		BY H.E. ES		JOB NO. 5571		ACCT					
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB. COST		DATE 3/89		EST		FB					
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV.									

400 AREA


 THE LUMMUS COMPANY
 Bloomfield

ESTIMATE SHEET

LINE	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	FB 404 LT. ENDS.							
2	20' ID 18' HT TK	1						
3	mm <input type="checkbox"/>							
4	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8							
5	DES PRESS 15" - 2 WG PSIG DES TEMP 150 OF							
6	DES PRESS kg/cm ² DES TEMP °C			30-				30,000
7	CAPACITY: 1000 BARRELS/ GALLONS/ M ³							
8	INTERNALS							
9	TYPE: CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> OR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>							
10	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input checked="" type="checkbox"/> ERECT. WT. TONS							
11	FB 405 BENZENE PRODUCT	1						
12	32' ID 32' HT TK							
13	mm <input type="checkbox"/>							
14	MAT C.S. CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8			20				20,000
15	DES PRESS 15" - 2" WG PSIG DES TEMP 120 OF							
16	DES PRESS kg/cm ² DES TEMP °C							
17	CAPACITY: 4500 BARRELS/ GALLONS/ M ³							
18	INTERNALS							
19	TYPE: CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> OR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>							
20	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input checked="" type="checkbox"/> ERECT. WT. TONS							
21	FB 406 TOLUENE PRODUCT	1						
22	22' ID 24' HT TK			25				40,000
23	mm <input type="checkbox"/>							
24	MAT CS CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8							
25	DES PRESS 15" - 2 WG PSIG DES TEMP 120 OF							
26	DES PRESS kg/cm ² DES TEMP °C							
27	CAPACITY: 1600 BARRELS/ GALLONS/ M ³							
28	INTERNALS							
29	TYPE: CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> OR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>							
30	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB-SHOP <input type="checkbox"/> FIELD <input checked="" type="checkbox"/> ERECT. WT. TONS	3						
TOTAL THIS PAGE								
TOTAL ACCOUNT								
CLIENT AMOCO/DUE-GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. M.H.		BY H.E. ES		ACCT FB
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB. COST		DATE 3/89		EST
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV.		REV.

400 AREA

LUMMUS		ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST		MATERIAL COST		STD LABOR MH		SUBCONTRACT COST					
		REQ	EA					UNIT		TOTAL					
1	FB 407	XYLENE PRODUCT													
2	12' ID 12' TT TK	1													
3	mm														
4	MAT CS														
5	DES PRESS														
6	DES PRESS														
7	CAPACITY: 200 BARRELS														
8	INTERNAL														
9	TYPE CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>														
10	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input checked="" type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>														
11	FB 408	GASOLINE BLEND STORAGE													
12	17' ID 18' TT TK														
13	mm														
14	MAT CS														
15	DES PRESS														
16	DES PRESS														
17	CAPACITY: 630 BARRELS														
18	INTERNAL														
19	TYPE CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>														
20	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input checked="" type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>														
21	FB 409	GASOLINE													
22	48' ID 40' TT TK														
23	mm														
24	MAT C.S.														
25	DES PRESS														
26	DES PRESS														
27	CAPACITY: 13000 BARRELS														
28	INTERNAL														
29	TYPE CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>														
30	INSUL <input type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input checked="" type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/>														
TOTAL THIS PAGE		3													
TOTAL ACCOUNT															
CLIENT ARMOCO/DOE GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. M.H.		BY		JOB NO.		ACCT					
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB. COST		DATE		EST		FB					
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV.									

400 AREA

THE LUMMUS COMPANY Bloomfield		ESTIMATE SHEET		QUANTITY		MATERIAL COST		9TD LABOR MH		SUBCONTRACT COST	
DESCRIPTION				REQ	EA	UNIT COST		UNIT	TOTAL		
1	FB 804	TAR PRODUCT									
2	30' ID	32' TT	TK	1							
3	mm		SKIRT HT								
4	MAT C.S.	CLAD	LINING	CA	14'						
5	DES PRESS	+5" - 2" WG	PSIG	DES TEMP	160						
6	DES PRESS		kg/cm ²	DES TEMP							
7	CAPACITY:	2800	BARRELS	GALLONS							
8	INTERNALS	HEATING COIL									
9	TYPE: CR	FR	DR	SPHERE	OTHERS	HORIZ	VERT				
10	INSUL	API	BULLET	FAB-SHOP	FIELD						
11	FB 805	PHENOL PRODUCT									
12	32' ID	32' TT	TK	1							
13	mm		SKIRT HT								
14	MAT C.S.	CLAD	LINING	CA	18'						
15	DES PRESS	+5" - 2" WG	PSIG	DES TEMP	160						
16	DES PRESS		kg/cm ²	DES TEMP							
17	CAPACITY:	4600	BARRELS	GALLONS							
18	INTERNALS	HEATING COIL									
19	TYPE: CR	FR	DR	SPHERE	OTHERS	HORIZ	VERT				
20	INSUL	API	BULLET	FAB-SHOP	FIELD						
21	FB										
22	ID	TT	TK								
23	mm		SKIRT HT								
24	MAT	CLAD	LINING	CA							
25	DES PRESS		PSIG	DES TEMP							
26	DES PRESS		kg/cm ²	DES TEMP							
27	CAPACITY:		BARRELS	GALLONS							
28	INTERNALS										
29	TYPE: CR	FR	DR	SPHERE	OTHERS	HORIZ	VERT				
30	INSUL	API	BULLET	FAB-SHOP	FIELD						
TOTAL THIS PAGE				2							
TOTAL ACCOUNT											
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT				PROD. FACT		LOC. M.H.		BY	AKES	JOB NO.	5571
LOCATION BEULAH, NORTH DAKOTA				WAGE RATE		LAB. COST		DATE	3/89	EST	
PROJECT JET FUEL FROM COAL-DERIVED LIQUIDS								REV.			FB

400 AREA

LUMMUS		ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY	UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST									
		REQ	EA		UNIT	TOTAL									
1	FB 910 22' ID 24' TT TK SKIRT HT	1													
2															
3	mm														
4	MAT C.S. CLAD Lining CA														
5	DES PRESS + 5" - 2" WG DES TEMP 160 OF														
6	DES PRESS kg/cm ² DES TEMP °C														
7	CAPACITY: 1600 BARRELS/ GALLONS/ M ³														
8	INTERNALS HEATING COIL														
9	TYPE: CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>														
10	INSUL <input checked="" type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input checked="" type="checkbox"/> ERECT WT TONS														
11	FB 912 M/P CRESOL PRODUCT	1													
12	25' ID 24' TT TK SKIRT HT														
13	mm														
14	MAT C.S. CLAD Lining CA 1/8"														
15	DES PRESS + 5" - 2" WG DES TEMP 160 OF														
16	DES PRESS kg/cm ² DES TEMP °C														
17	CAPACITY: 2100 BARRELS/ GALLONS/ M ³														
18	INTERNALS HEATING COIL														
19	TYPE: CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>														
20	INSUL <input checked="" type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input checked="" type="checkbox"/> ERECT WT TONS														
21	FB 913 2,3/2,4 XYLENOL PRODUCT	1													
22	14' ID 16' TT TK SKIRT HT														
23	mm														
24	MAT C.S. CLAD Lining CA 1/8"														
25	DES PRESS + 5" - 2" WG DES TEMP OF														
26	DES PRESS kg/cm ² DES TEMP °C														
27	CAPACITY: 440 BARRELS/ GALLONS/ M ³														
28	INTERNALS HEATING COIL														
29	TYPE: CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>														
30	INSUL <input checked="" type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input checked="" type="checkbox"/> ERECT WT TONS														
TOTAL THIS PAGE		3													
TOTAL ACCOUNT															
CLIENT HANCO/DUE-GREAT PLAINS GASIF. PLANT		PROD. FACT	LOC. M.H.	LAB. COST	BY HAE-ES	DATE 3/85	REV.	ACCT FB	JOB NO. 5571	EST					
LOCATION BEULAH, NORTH DAKOTA		WAGERATE													
PROJECT TET FUEL FROM COAL DERIVED LIQUIDS															

400 AREA

THE LUMMUS COMPANY
Bloomfield

ESTIMATE SHEET

LINE	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	FB 914 MIXED XYLENOL PRODUCT	1						
2	18' ID 18' TT SKIRT HT							
3	mm <input type="checkbox"/>							
4	MAT C-S. CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA 1/8							
5	DES PRESS 5" - 2" HG DES TEMP 160 °F			35-				30000
6	DES PRESS kg/cm ² DES TEMP °C							
7	CAPACITY 820 BARRELS GALLONS M ³							
8	INTERNALS HEATING COIL							
9	TYPE CR <input checked="" type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input checked="" type="checkbox"/>							
10	INSUL <input checked="" type="checkbox"/> API <input checked="" type="checkbox"/> BULLET <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input checked="" type="checkbox"/> ERECT WT TONS							
11	FB							
12	ID TT TK SKIRT HT							
13	mm <input type="checkbox"/>							
14	MAT CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA							
15	DES PRESS PSIG DES TEMP °F							
16	DES PRESS kg/cm ² DES TEMP °C							
17	CAPACITY BARRELS GALLONS M ³							
18	INTERNALS							
19	TYPE CR <input type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/>							
20	INSUL <input type="checkbox"/> API <input type="checkbox"/> BULLET <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/> ERECT WT TONS							
21	FB							
22	ID TT TK SKIRT HT							
23	mm <input type="checkbox"/>							
24	MAT CLAD <input type="checkbox"/> LINING <input type="checkbox"/> CA							
25	DES PRESS PSIG DES TEMP °F							
26	DES PRESS kg/cm ² DES TEMP °C							
27	CAPACITY BARRELS GALLONS M ³							
28	INTERNALS							
29	TYPE CR <input type="checkbox"/> FR <input type="checkbox"/> DR <input type="checkbox"/> SPHERE <input type="checkbox"/> OTHERS <input type="checkbox"/> HORIZ <input type="checkbox"/> VERT <input type="checkbox"/>							
30	INSUL <input type="checkbox"/> API <input type="checkbox"/> BULLET <input type="checkbox"/> FAB SHOP <input type="checkbox"/> FIELD <input type="checkbox"/> ERECT WT TONS							
	TOTAL THIS PAGE	1						
	TOTAL ACCOUNT	16						
CLIENT HUNOCO/DOW-GREAT PLAINS GASIF. PLANT		PROD. FACT		LOC. M.H.		JOB NO. 5571		ACCT FB
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB. COST		DATE 7/87		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						REV		

400 AREA

LUMMUS		ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST								
		REQ	EA			UNIT	TOTAL			BY	DATE	REV.			
1	GA 401/s	2													
2	GPM 110														
3	PSIG DISCH														
4	TEMP 160 OF														
5	SUCT														
6	PSIG DISCH														
7	TEMP														
8	SP GR 1.0														
9	ΔP														
10	ΔP														
11	MAT CASE CS/SS IMPELLER														
12	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER														
13	TYPE CENT - <input type="checkbox"/> RECIP <input checked="" type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI														
14	MECH SEAL <input checked="" type="checkbox"/>														
15	INSUL <input type="checkbox"/>														
16	GA 402/s	2													
17	GPM 30														
18	PSIG DISCH														
19	TEMP 120 OF														
20	SUCT														
21	PSIG DISCH														
22	TEMP														
23	SP GR														
24	ΔP														
25	ΔP														
26	MAT CASE CS IMPELLER 12 CY														
27	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER														
28	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI														
29	MECH SEAL <input checked="" type="checkbox"/>														
30	INSUL <input checked="" type="checkbox"/>														
TOTAL THIS PAGE		6													
TOTAL ACCOUNT															
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT															
LOCATION BEULAH, NORTH DAKOTA															
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS															
JOB NO. 5571															
ACCT GA															

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400 AREA

LUMMUS		ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST							
		REQ	EA			UNIT	TOTAL								
1	GA 404/S STABIL. NAPHTHA TRANSFER	2													
2	GPM 400				22 000										
3	m ³ /h														
4	SP GR														
5															
6	MAT CASE CS														
7	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>														
8	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>														
9	MECH SEAL <input checked="" type="checkbox"/>														
10	INSUL <input type="checkbox"/>														
11	GA 405/S CRUDE NAPHTHA FEED	2			15000										
12	GPM 25														
13	m ³ /h														
14	SP GR 0.71														
15															
16	MAT CASE														
17	DRIVE EM - <input type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>														
18	TYPE CENT - <input type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>														
19	MECH SEAL <input type="checkbox"/>														
20	INSUL <input type="checkbox"/>														
21	GA 406/S GASOLINE BLENDING STOCK TRANS.	2			15000										
22	GPM 75														
23	m ³ /h														
24	SP GR 0.89														
25															
26	MAT CASE CS														
27	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>														
28	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>														
29	MECH SEAL <input checked="" type="checkbox"/>														
30	INSUL <input type="checkbox"/>														
TOTAL THIS PAGE		6													
TOTAL ACCOUNT															
CLIENT HILCO/DOE - GREAT PLAINS GASIF. PLANT		LOC. M.H.		BY HLEJ		JOB NO 5571		ACT GA							
LOCATION BEULAH, NORTH DAKOTA		LAB. COST		DATE 3/87		EST		REV							
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS		WAGE RATE													



LUMMUS

400 AREA

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION										QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST			
										REQ	EA							
ERECT WT. PUMP & DRIVER										TONS								
1	GA	407/5	BENZENE TRANSFER							2								
2	GPM	200	SUCT	PSIG	DISCH	PSI	TEMP	100 OF										
3	m ³ /h		SUCT	PSIG	DISCH	PSI	TEMP	100 OF										
4	SP GR	0.89	ΔP	FT		50	PSI	STGS										
5			ΔP	m			PSI	RPM										
6	MAT CASE	CS	IMPELLER 12 CP															
7	DRIVE EM -	<input checked="" type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER														
8	TYPE CENT -	<input checked="" type="checkbox"/> RECIP	<input type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	<input type="checkbox"/> API	<input type="checkbox"/> ANSI												
9	MECH SEAL	<input checked="" type="checkbox"/>																
10	INSUL	<input type="checkbox"/>																
ERECT WT. PUMP & DRIVER										TONS								
11	GA	408/5	TOLUENE TRANSFER							2								
12	GPM	150	SUCT	PSIG	DISCH	PSI	TEMP	OF										
13	m ³ /h		SUCT	PSIG	DISCH	PSI	TEMP	OF										
14	SP GR	.87	ΔP	FT		50	PSI	STGS										
15			ΔP	m			PSI	RPM										
16	MAT CASE	CS	IMPELLER 12 CP															
17	DRIVE EM -	<input checked="" type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER														
18	TYPE CENT -	<input checked="" type="checkbox"/> RECIP	<input type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	<input type="checkbox"/> API	<input type="checkbox"/> ANSI												
19	MECH SEAL	<input checked="" type="checkbox"/>																
20	INSUL	<input type="checkbox"/>																
ERECT WT. PUMP & DRIVER										TONS								
21	GA	409/5	XYLENE TRANSFER							2								
22	GPM	25	SUCT	PSIG	DISCH	PSI	TEMP	100 OF										
23	m ³ /h		SUCT	PSIG	DISCH	PSI	TEMP	100 OF										
24	SP GR	.88	ΔP	FT		50	PSI	STGS										
25			ΔP	m			PSI	RPM										
26	MAT CASE	CS	IMPELLER 12 CP															
27	DRIVE EM -	<input checked="" type="checkbox"/> TURB	<input type="checkbox"/> DIESEL	<input type="checkbox"/> OTHER														
28	TYPE CENT -	<input checked="" type="checkbox"/> RECIP	<input type="checkbox"/> PROP	<input type="checkbox"/> OTHERS	<input type="checkbox"/> API	<input type="checkbox"/> ANSI												
29	MECH SEAL	<input checked="" type="checkbox"/>																
30	INSUL	<input type="checkbox"/>																
ERECT WT. PUMP & DRIVER										TONS								
TOTAL THIS PAGE										6								
TOTAL ACCOUNT																		
CLIENT ANCOG/Doe - GREAT PLAINS GASIF. PLANT										LOC. M.H.				BY	DATE	REV.	ACCT	
LOCATION BEULAH, NORTH DAKOTA										LAB. COST							GA	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS										WAGER RATE								

400 AREA

LUMMUS		ESTIMATE SHEET										THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST							
		REQ	EA			UNIT	TOTAL								
1	GA 410/5 IP-8 TRANSFER	2													
2	GPM 1000														
3	PSIG DISCH														
4	PSIG DISCH														
5	FT														
6	PSI														
7	IMPELLER														
8	CS														
9	IMPELLER 12CI														
10	IMPELLER 12CI														
11	IMPELLER 12CI														
12	IMPELLER 12CI														
13	IMPELLER 12CI														
14	IMPELLER 12CI														
15	IMPELLER 12CI														
16	IMPELLER 12CI														
17	IMPELLER 12CI														
18	IMPELLER 12CI														
19	IMPELLER 12CI														
20	IMPELLER 12CI														
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24	IMPELLER 12CI														
25	IMPELLER 12CI														
26	IMPELLER 12CI														
27	IMPELLER 12CI														
28	IMPELLER 12CI														
29	IMPELLER 12CI														
30	IMPELLER 12CI														
TOTAL THIS PAGE		6													
TOTAL ACCOUNT															
CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT															
LOCATION BEULAH, NORTH DAKOTA															
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS															
BY HZ ES															
DATE 3/85															
REV.															
JOB NO. 5571															
ACCT GA															

400 AREA

LUMMUS		ESTIMATE SHEET		THE LUMMUS COMPANY Bloomfield			
DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH	SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL
1	GA 413/S 300" LT ENDS TRANSFER	2					
2	GPM 100				15000		
3	PSIG DISCH						
4	TEMP 120 OF						
5	PSIG DISCH						
6	TEMP 50 PSI						
7	STGS						
8	RPM						
9	HP						
10	IMPELLER 12 CM						
11	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>						
12	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>						
13	MECH. SEAL <input checked="" type="checkbox"/>						
14	INSUL <input checked="" type="checkbox"/>						
15	ERECT WT. PUMP & DRIVER						
16	GA 414/S TAR PRODUCT TRANSFER	2			20000		
17	GPM 200						
18	PSIG DISCH						
19	TEMP 160 OF						
20	PSIG DISCH						
21	TEMP 50 PSI						
22	STGS						
23	RPM						
24	HP						
25	IMPELLER 12 CM						
26	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/>						
27	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>						
28	MECH. SEAL <input checked="" type="checkbox"/>						
29	INSUL <input checked="" type="checkbox"/>						
30	ERECT WT. PUMP & DRIVER						
31	TOTAL THIS PAGE	6					
32	TOTAL ACCOUNT						
33	CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT						
34	LOCATION BEULAH, NORTH DAKOTA						
35	PROJECT JET FUEL FROM COAL DERIVED LIQUIDS						
36	BY <u>HEE CS</u>						
37	DATE <u>3/89</u>						
38	REV.						
39	LOC. M.H.						
40	LAB. COST						
41	ACCT						
42	GA						
43	JOB NO. <u>5571</u>						
44	EST						

400 AREA



ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION		QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	GA 416/5 0-CRESOL TRANS.	2						
2	GPM 150 SUCT PSIG DISCH PSI TEMP 120 OF				15000			
3	m ³ /m SUCT SUCT PSIG DISCH PSI TEMP 120 OF							
4	SP GR 0.98 DP FT 50 PSI STGS							
5	DP DP m ³ /m ² RPM							
6	MAT CASE CS IMPELLER 12 CV 7 1/2 HP							
7	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/> KW							
8	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
9	MECH SEAL <input checked="" type="checkbox"/>							
10	INSUL <input checked="" type="checkbox"/> ERECT WT PUMP & DRIVER TONS							
11	GA 417/5 MP CRESOL TRANS.	2						
12	GPM 200 SUCT PSIG DISCH PSI TEMP 120 OF				15000			
13	m ³ /m SUCT SUCT PSIG DISCH PSI TEMP 120 OF							
14	SP GR 1.035 DP FT 50 PSI STGS							
15	DP DP m ³ /m ² RPM							
16	MAT CASE CS IMPELLER 12 CV 10 HP							
17	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/> KW							
18	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
19	MECH SEAL <input checked="" type="checkbox"/>							
20	INSUL <input checked="" type="checkbox"/> ERECT WT PUMP & DRIVER TONS							
21	GA 418/5 2 1/2 CRESOL TRANSFEA	2						
22	GPM 50 SUCT PSIG DISCH PSI TEMP 120 OF				15000			
23	m ³ /m SUCT SUCT PSIG DISCH PSI TEMP 120 OF							
24	SP GR 0.97 DP FT 50 PSI STGS							
25	DP DP m ³ /m ² RPM							
26	MAT CASE CS IMPELLER 12 CV 2 1/2 HP							
27	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/> KW							
28	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
29	MECH SEAL <input checked="" type="checkbox"/>							
30	INSUL <input checked="" type="checkbox"/> ERECT WT PUMP & DRIVER TONS							
TOTAL THIS PAGE		6						
TOTAL ACCOUNT								
CLIENT AMOCO/DOE - GREAT PLAINS GASIF PLANT		PROD FACT		LOC. M.H.	BY	EST	NO.	ACCT
LOCATION BEULAH, NORTH DAKOTA		WAGE RATE		LAB. COST	DATE	REV.		GA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS					3/87		5571	

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400 AREA



LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

ITEM	DESCRIPTION	QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
		REQ	EA			UNIT	TOTAL	
1	GA 419/1 MIXED XYLENOL TRANS.	2			15000			
2	GPM 100 SUCT PSIG DISCH PSI TEMP 120 OF							
3	m ³ /h SUCT SUCT h _g /cm ² DISCH h _g /cm ² TEMP OC							
4	SP GR 0.91 ΔP FT 50 PSI STGS							
5	ΔP m h _g /cm ² RPM							
6	MAT CASE CS IMPELLER 1201 5 HP							
7	DRIVE EM - <input checked="" type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/> kW							
8	TYPE CENT - <input checked="" type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
9	MECH SEAL <input checked="" type="checkbox"/>							
10	INSUL <input type="checkbox"/> ERECT WT PUMP & DRIVER TONS							
11	GA							
12	GPM SUCT SUCT PSIG DISCH PSI TEMP OF							
13	m ³ /h SUCT SUCT h _g /cm ² DISCH h _g /cm ² TEMP OC							
14	SP GR ΔP FT PSI STGS							
15	ΔP m h _g /cm ² RPM							
16	MAT CASE IMPELLER HP							
17	DRIVE EM - <input type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/> kW							
18	TYPE CENT - <input type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
19	MECH SEAL <input type="checkbox"/>							
20	INSUL <input type="checkbox"/> ERECT WT PUMP & DRIVER TONS							
21	GA							
22	GPM SUCT SUCT PSIG DISCH PSI TEMP OF							
23	m ³ /h SUCT SUCT h _g /cm ² DISCH h _g /cm ² TEMP OC							
24	SP GR ΔP FT PSI STGS							
25	ΔP m h _g /cm ² RPM							
26	MAT CASE IMPELLER HP							
27	DRIVE EM - <input type="checkbox"/> TURB <input type="checkbox"/> DIESEL <input type="checkbox"/> OTHER <input type="checkbox"/> kW							
28	TYPE CENT - <input type="checkbox"/> RECIP <input type="checkbox"/> PROP <input type="checkbox"/> OTHERS <input type="checkbox"/> API <input type="checkbox"/> ANSI <input type="checkbox"/>							
29	MECH SEAL <input type="checkbox"/>							
30	INSUL <input type="checkbox"/> ERECT WT PUMP & DRIVER TONS							
TOTAL THIS PAGE		2						
TOTAL ACCOUNT		38						
CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT		JOB NO. 5571		ACCT GA				
LOCATION BEULAH, NORTH DAKOTA		DATE 3/8/85		EST				
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS		REV.						

F-211

APPENDIX G

Letter from D. P. Daley to J. G. Masin, March 3, 1989.
"GPGP By-product Marketing Assessment"



Burns and Roe Services Corporation
P.O. Box 18288, Pittsburgh, PA 15236 • 412-892-4701

March 3, 1989
DPD-89-154

Mr. J. G. Masin
Amoco Oil Company
Research and Development Department
P.O. Box 400
Naperville, Illinois 60566

Subject: Contract No. DE-AC22-87PC79338
Subtask 3.03
GPGP By-Product Marketing Assessment

Dear Mr. Masin:

In response to your request for recent market information on the GPGP by-products, attached please find a Market Assessment performed by Stanford International for Fluor. This assessment was presented in Fluor's January 1989 report to the U.S. DOE entitled "Great Plains Coal Gasification Plant - By-Products Development Program Summary Report".

If you have any questions, please contact S.N. Rao at (412) 892-4716 or R.J. Rossi at (412) 892-4845.

Very truly yours,

Donald P. Daley
Project Director

RR/jm

Attachment

cc: R. Carabetta
G. McGurl w/attachment
J. Parise (2)
G. Reule
G. Stiegel w/attachment
P. LaRosa w/attachment ✓
S.N. Rao w/attachment
R. Rossi w/attachment
W. Harrison (USAF) w/attachment
A. Kuhn (DGC) w/attachment

2.2 Task #2 - Market Assessment

2.2.1 Objective

The objective of this task was to obtain from an independent source a comprehensive market analysis to help determine the most promising by-products for development and marketing and to prioritize the development and marketing among the by-products. The marketing analysis was executed by Stanford International (SI) of Menlo Park, California (formerly called Stanford Research Institute).

2.2.2 Scope

The scope of the study was as follows:

1. Assessment of markets
2. Exploration of pricing criteria for products
3. Matching products with markets.

Each of these items is discussed below.

The market assessment was based on consideration of the following market considerations:

- Supply and demand evaluation of domestic and where applicable foreign markets.
- An analysis of the production capacity by domestic and foreign producers.
- Evaluation of imports and exports, trade limitations and transportation issues.
- Survey of announced and potential manufacturing expansions.
- Projections of the impact of new technologies, new products, and existing commodity replacements.

For all of the above considerations historical and forecast information was used. SI is continuously updating a series of books for various chemicals and commercial gas. Input was received from the proprietary background information

Rather than relying on historical data for price projections, the scope of the project was aimed at exploring pricing criteria for the various products and then projecting future pricing and trends based on these criteria. The basic presumption was that prices are market driven; that is, the price of a product is solely a function of basic market elements and is not affected by political pressures, foreign cartels, trade sanctions or other undeterminate events.

The potential by-products had to be evaluated in view of existing, competitive products, therefore, the scope of the task included matching the volume and quality of the potential by-products with those currently marketed. DGC provided SI with anticipated volumes, composition and quality of the potential products.

2.2.3 Technical Approach

SI's technical approach to execution of the task was based on:

- Contacting suppliers and product users
- Using published surveys and trade journals
- Using SI's own nonproprietary data base

Primary information was obtained by contacting individual suppliers and users of the respective products under evaluation. Nonproprietary and proprietary information thus collected was evaluated and compared. The requested information focused on the three main elements of the work scope, namely: assessing the market, exploring pricing and required product quality. Also, inquiries were made about projected expansion or termination of current production. Product users were also queried whether or not a coal derived product would be acceptable for their raw material purchases.

Published literature was another source of information. Because the depth of the study was limited, information on foreign markets and price trends was mostly obtained from available publications.

In executing the project, SI also relied on its applicable proprietary data base. SI's data base information complemented and augmented the above mentioned information sources.

2.2.4 Task Description

DGC defined the following product slate for evaluation and provided the potential quantities that could be produced:

	Annual Production, MM Lbs/Year
Phenol	37
Ortho cresol	10
Meta-para cresol mix	26.4
m-Ethyl phenol	7.6
2,3-Xylenol	
p-Ethyl phenol	
3,4-Xylenols	1.7
3,5-Xylenols	3.4
2,4-, 2,5-Xylenol	6.5
Creosote	27
Aromatic naphtha, millions of U.S. gallons/yr	10
Carbon dioxide, million standard cubic feet/day	180
Argon, thousands of short tons/yr	34.5
Krypton, Xenon, millions of liters/yr	2.6

Accordingly, SI evaluated each commodity as defined by the objective and scope of the project.

2.2.5 Results and Conclusions

The target markets defined in this section are domestic ones for phenol, aromatics, carbon dioxide and argon. All others include an export component.

2.2.5.1 Phenol

Projected Production:	37 MM lb/yr
Percent of U.S. Capacity (1987):	1.1
Markets Accessible to DGC (1992):	300 MM lb/yr

SI's assessment projects that provided DGC markets specification grade phenol (with no impurities that are characteristics of coal derived phenols) a good market potential exists in the 1990-1995 timeframe. Because no demand decrease is forecast and because synthetic phenol will require a premium price due to firm benzene and propylene prices, one can expect a firm netback value of 45-50 c/lb for phenol. However, because of the cyclical nature of the chemical market, the opportunities should be exploited in the near future to establish a position.

2.2.5.2 Cresols

Projected Production	
Ortho Cresol	10 MM lb/yr
Meta-Para Cresol Mix	26.4 MM lb/yr
Percent of U.S. Capacity (1987)	
Ortho Cresol	40
Meta-Para Cresol Mix	91
Markets Accessible to DGC (1992)	
Ortho Cresol	80 MM lbs/yr (including exports)
Meta-Para Cresol Mix	50 MM lbs/yr (including exports)

As the above figures show, DGC's cresol production would be a dominant share of the U.S. market. In the markets accessible to DGC certain foreign markets are included and the possibility of export must be followed up to confirm market potential abroad. Overall, the cresol market is difficult to penetrate. Demand is in decline and users are looking for substitute chemicals because the toxicity of cresols has been called into question by the USEPA and is presently being investigated. Cresol prices are very much subject to wide cycling, and the entry of a large volume of cresols would certainly suppress the price.

However, a number of cresol producers may close plants and abandon the market. Therefore, for specific use a small segment of the domestic market for quality products may open.

2.2.5.3 Xylenols

Projected Production

m-Ethyl phenol	7.6 MM lbs/yr
2,3-Xylenol	
p-Ethyl phenol	
3,4-Xylenols	1.7 MM lbs/yr
3,5-Xylenols	3.4 MM lbs/yr
2,4-, 2,5-Xylenols	6.5 MM lbs/yr

Present U.S. Capacity (1987)

m-Ethyl phenol	20.5
2,3-Xylenol	
p-Ethyl phenol	
3,4-Xylenols	10.5
3,5-Xylenols	
2,4-, 2,5-Xylenols	

Markets Accessible to DGC (1992)

m-Ethyl phenol	10 MM lbs/yr
2,3-Xylenol	
p-Ethyl phenol	
3,4-Xylenols	50 MM lbs/yr
3,5-Xylenols	
2,4-, 2,5-Xylenols	

The market for Xylenols, like Cresols, is on the decline. The largest volume demand of Xylenol is the 2,6 Xylenol which is largely produced synthetically and consumed by the producers. Unfortunately, DGC's Xylenol stream has practically no 2,6 Xylenol. On the other hand 2,4 Xylenol are used in the production of antioxidants, 3,5 Xylenols for fungicides, since Xylenols must be tailored to specific applications it will be very difficult to move all the Great Plains volumes of Xylenols within the USA.

2.2.5.4 Creosote

Projected Production:	27 MM lbs/yr
Percent of U.S. Capacity (1987)	39
Markets Accessible to DGC (1992)	60 MM lbs/yr

Creosote demand is steadily declining because of its high toxicity, extensive regulatory obligations and shrinking end use. No new technical applications are expected.

2.2.5.5 Aromatics

Projected Production	10 MM gallon/yr
Percent of US Capacity (1987)	7.1
Markets Accessible to DGC (199-)	3,000 MM gallon/yr

The Rectisol naphtha contains a large percentage of aromatics: benzene, toluene, and xylenes (BTX) (See Section 2.3). As such, it is a valuable raw material; however, this stream is relatively low in volume: about 650 barrels per day (10 MM gallon/yr). In view of a strong demand for these aromatics, the market potential for this stream is favorable. Because of the poor economics involved in processing such small quantities, the mixture should be shipped to a refiner and processed there with pyrolysis gasoline to extract the benzene, toluene and xylenes rather than separating the individual compounds at the plant site. However, because of objectionable odor and toxicity the high sulfur content and gumming tendency from the diolefins present, this stream must undergo catalytic hydrotreating and stabilization to make it suitable for shipping.

2.2.5.6 CO₂

Projected Production	180 MMSCFD
Percent of U.S. Capacity (1987)	Not applicable
Markets Accessible to DGC (1992)	>120 MMSCFD

DGC currently produces 180-200 MMSCFD of low BTU (40-50 Btu/SCF) waste gas that is used as an auxiliary fuel in the boilers. This stream contains about 95-96 percent CO₂. SI evaluated the market potential of this gas stream for CO₂ flooding in enhanced oil recovery applications.

The survey confirmed the potential demand of CO₂ in the Williston basin in Western North Dakota and eastern Montana as well as in Canada. However, this demand is contingent on crude prices. Table 2-1 lists the crude price and the respective CO₂ price that justify the economics of enhanced oil recovery. To justify the economics of enhanced oil recovery, the CO₂ price should not exceed 20-30 percent of the crude price (dollars per barrel) assuming that 7,000 SCF of CO₂ is used to produce one incremental barrel of crude oil.

TABLE 2-1

CO₂ PRICE VS. CRUDE OIL PRICE

<u>Year</u>	<u>Carbon Dioxide¹ (dollars per thousand cubic feet)</u>	<u>Crude Oil² (dollars per barrel)</u>
1983	1.50	29.35
1984	N/A	28.87
1985	N/A	26.80
1986 (Jan)	0.80-1.50	25.78
1986 (Mar)	0.40-0.60	14.56
1987		17.54

¹Price for product delivered to Denver City, Texas.

²Crude oil first purchase price in Texas.

Sources: Petroleum Marketing Monthly, Energy Information Administration (crude oil prices); SI estimates (carbon dioxide prices).

The assessment also reaffirmed that the CO₂ delivery must be via a pipeline. The construction of a pipeline, however, may pose difficulties both financially and with respect to permitting.

2.2.5.7 Argon

Projected Production	34,500 short tons/year
Percent of US Capacity (1987)	7
Markets Accessible to DGC (1992)	200,000 short tons/year

The demand for Argon has grown appreciably in the last 15-20 years and is expected to level off in the near term. The Argon market is dominated by a few major producers; Air Products, Air Liquide and Union Carbide. With appropriate market strategy DGC has good potential to penetrate and capture a fair share of the North, Southern/North Central market of the United State.

2.2.5.8 Krypton, Xenon

Projected Production	2.6 MM liters/year
Percent of US Capacity (1987)	54
Markets Accessible to DGC (1992)	small


There is only limited market for these two rare gases. The projected market for Krypton is in decline while Xenon projections show an upward trend. Thus, market potential for Krypton is less than marginal, while for Xenon it is better than marginal.

2.2.6 Recommendations

SI's recommendations can be summarized as follows:

1. Current users of the chemical commodities that SI evaluate for DGC are geared to raw materials synthetically manufactured. These users will not relax specifications and will require products of equal quality than those derived from synthetics. Therefore, DGC must develop by-products upgrading processes, which assure high quality products.
2. Phenol, Argon and aromatics from naphtha are the products with the largest market potential. Therefore, primary efforts should be concentrated on developing these three commodities. Necessary purification processes should be pursued and a marketing strategy should be developed.

The naphtha stream must be desulfurized and saturated via catalytic hydrogenation in order to make the material amenable to rail or truck transport. Secondly, a refiner for aromatics extraction should be located within reasonable distance to minimize transport costs.

3. CO₂ potential for enhanced oil recovery application is contingent on two essential factors: oil prices and pipeline availability. Because higher oil prices are not predicted for the near futures, CO₂ marketing for DGC must be considered only in the long term.
 4. The marketing potential of Krypton and Xenon is marginal, and development of these two low volume commodities should not be abandoned but should receive low priority.
 5. Cresols and xylenols required a firm, long term export commitment to justify their full development and marketing.
 6. Creosote development should not be pursued, at least as a single product direct from tar oil.
- 

APPENDIX H

LCI Report on Task 5:
Production Run Recommendation

APPROACH TO TASK 5

A. DEMONSTRATION RUN IN A CONVENTIONAL REFINERY

Experimental work by Amoco Research has shown that the upgrading of Tar Oil to JP-8 Aviation Turbine Fuel is possible under the following conditions:

- o Staged deep hydrotreating
- o 2000 psig reactor pressure
- o Low space velocity (WHSV = 0.25 Overall)
- o Catalyst with high denitrogenation activity

The flow system, recommended by Amoco Research (Figure 1), would be difficult to set up in U.S. refineries because the two existing expanded bed units are too large and a 10,000 Bbl test run would be contaminated by the inventory of the systems. An alternate approach, based on a modified two stage hydrocracker, should be able to provide an acceptable product. This alternate approach consists of five steps:

- o Hot filtration of the Tar Oil to remove the 0.5% solids content. While most hydrocrackers have a feed filter, the amount contained in the Tar Oil is higher than petroleum vacuum gas oil and a prefiltration is advisable to ensure a smooth run.
- o Operation of the hydrocracker in a recycle mode through the first stage of the hydrocracker only (which contains a denitrogenation catalyst) to remove the nitrogen, sulfur, and oxygen, and to saturate aromatics. This hydrotreating step is run with a 6/1 product/feed recycle to control heat effects and to ensure that the desired degree of hydrotreating is obtained.
- o Fractionation of the hydrotreated products.
- o Hydrocracking of the 550°F+ material using both stages of the hydrocracker with recycle to extinction.
- o Clay treating of the jet fuel product produced.

Referring to Figure 2 and Table I, the filtration, hydrotreating and fractionation steps are as follows:

- o 15,000 Bbl of Tar Oil are hot filtered and sent to storage.
- o The hydrocracker is modified to permit by-passing of the second stage.
- o The first stage of the hydrocracker is operated with a 6/1 recycle/feed ratio.

- o The effluent is fractionated and sent to two product tanks:
 - 275/550°F Jet Fuel
 - 550°F+ Gas Oil
- o The fuel gas and naphtha are sent to the refinery for further processing.
- o Operation continues with recycle from the above tanks in the amounts indicated in Table I until all of the fresh Tar Oil feed is consumed.
- o Operation then proceeds with feed only from the product tanks until the products in the two tanks reach the following quality goals:
 - 275/550°F Jet Fuel reaches the desired density and aromatics content.
 - 550°F+ gas oil nitrogen and oxygen content is reduced to less than 100 ppm/wt each.

Referring to Figure 3 and Table I, the hydrotreating and clay treating steps are accomplished as follows:

- o The hydrocracker is returned to normal operation and charged with the hydrotreated 550°F+ gas oil. The hydrocracker operates with a 30% recycle.
- o The first stage of the hydrocracker reduces the nitrogen content from less than 100 ppm/w to less than 10 ppm/w.
- o The second stage of the hydrocracker converts about 70% of the fresh feed to jet fuel and naphtha per pass.
- o The jet fuel fraction from the hydrocracker is combined with the jet fuel fraction from the hydrotreating step and clay treated. The feed rate to the clay treater is adjusted to obtain a 1 ft./min. superficial velocity.
- o Antioxidant is added (UOP-U3444 at 2.8 PPM) and the product is sent to storage.

Assuming that the required product quality is obtained at a recycle ratio between 6/1 and 9/1 (fresh feed between 10-15% of total feed to reactor) and the desired run length for the demonstration run is about

10 days, we calculate that the hydrocracker capacity should be 6,000 - 10,000 BPSD. Allowing for turndown and allowing the test to range from 5 to 30 days, the acceptable range of hydrocracker capacity would be 3,000 - 30,000 BPSD.

With the above range in mind, Table II was prepared which lists refineries which have hydrocrackers with a capacity of 3,000 - 30,000 BPSD, and the capability of converting at least 50% of feed to lighter distillates. The refineries given in Table II should be able to meet the following conditions but this will have to be established by contract with the refineries:

1. Reactor total pressure of at least 2,000 psig.
2. Two stage hydrocracker with first stage containing desulfurization/denitrogenation catalyst.
3. First stage hydrogen addition potential of at least 500 SCF/Bbl available.
4. Ability to fractionate reactor effluent and recycle unconverted gas oil.

If it is decided to prepare 10,000 Bbl of Jet fuel from Tar Oil, then a letter should be drafted to the refineries given in Table II outlining the desired test, the requirements needed for the hydrotreating/hydrocracking step (given above), the material balance given in Table I, and requesting the refiner's interest in preparing the 10,000 Bbl of jet fuel.

B. DEMONSTRATION RUN IN OTHER FACILITIES

In addition to the refineries listed in Table II, there are some other leads which should be investigated which could provide the proper processing conditions:

1. Syncrude Canada has high pressure hydrotreating facilities for Bitumen which could be used for processing coal tar liquids. Their address is as follows:

Syncrude Canada Ltd.
P. O. Bag 4023 MD 1000
Fort McMurray AB, T9H 3H5
Canada
403-790-6111

2. Southern Services" Advanced Coal Liquefaction Facilities have a small pilot plant (20 BPSD) which has high pressure reactors. Their address is as follows:

Wilsonville Advanced Coal
Liquefaction Facility
P. O. Drawer 329
Wilsonville, Alabama 35106
Contact: Bill Hollenack

3. Unocal had operated a Shale Oil upgrading facility in the past in Parachute Creek. No current address is available but Union Oil in Brea, California could be contacted at the following address:

Unocal Science & Technology Division
376 South Valencia Ave.
Brea, California 92621
714-528-7201
Contact: C. P. Reeg
V. P. of Chemical Research

4. Ashland Oil had operated the H-Coal project in Cattlesburg, Kentucky. This 600-1800 BPSD facility is now shut down. The contact is as follows:

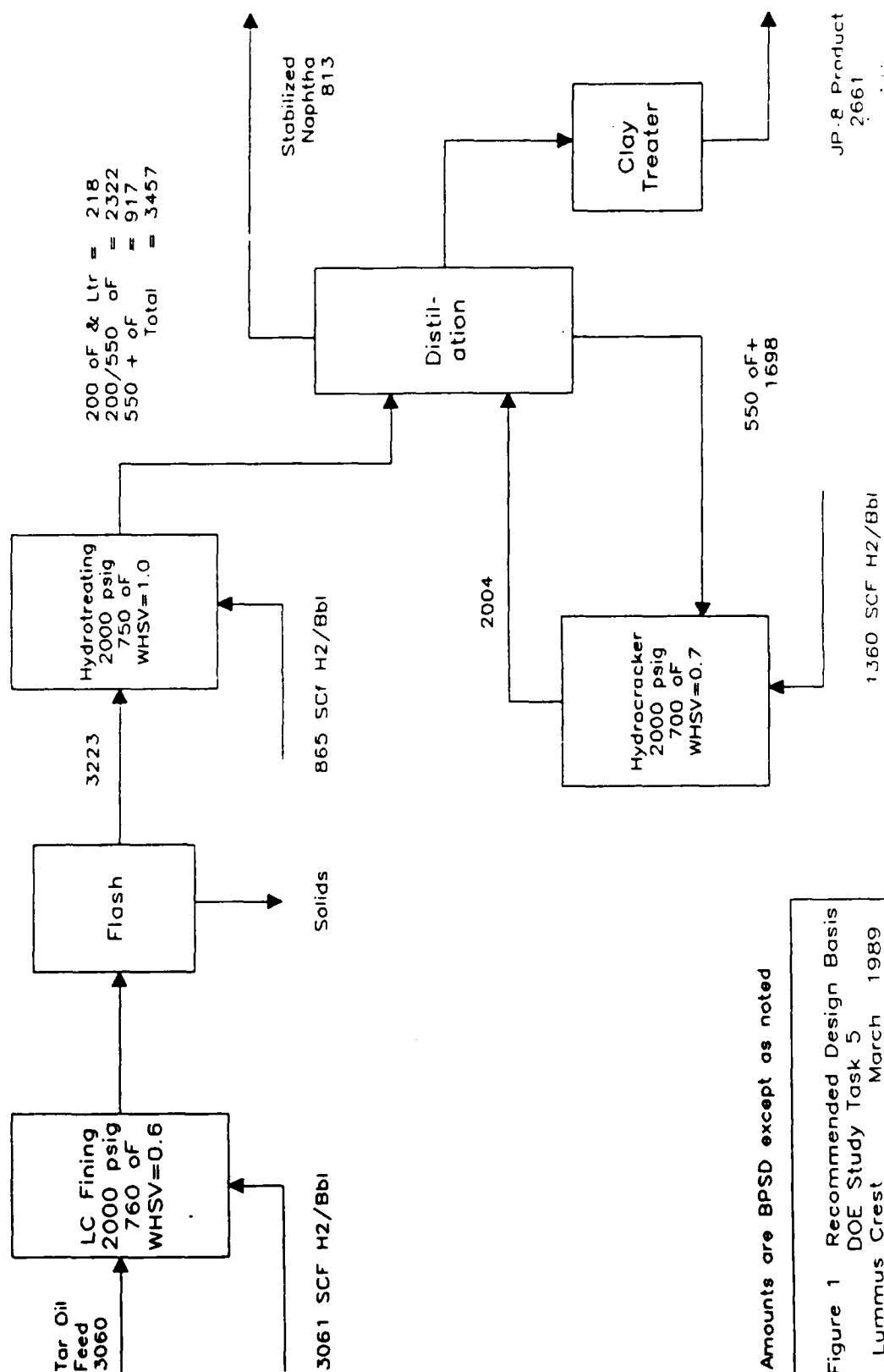
Charles Hoertz
President Ashland Synthetic Fuels
2000 Ashland Drive
Russel, Kentucky 41169
606-329-3333

5. Gary Refining has processed Shale Oil in the past and may still have the equipment. Their address is as follows:

Gary Refining Company
115 Inverness Drive
Englewood, Colorado 80112
303-797-3800
Contact: Victor Baraldi

6. SASOL in South Africa has hydrotreated Tar Oil in the past to produce distillate fuels.

Figure 1 Recommended Process Design Basis



Amounts are BPSD except as noted

Figure 1 Recommended Design Basis
DOE Study Task 5
Lummus Crest March 1989

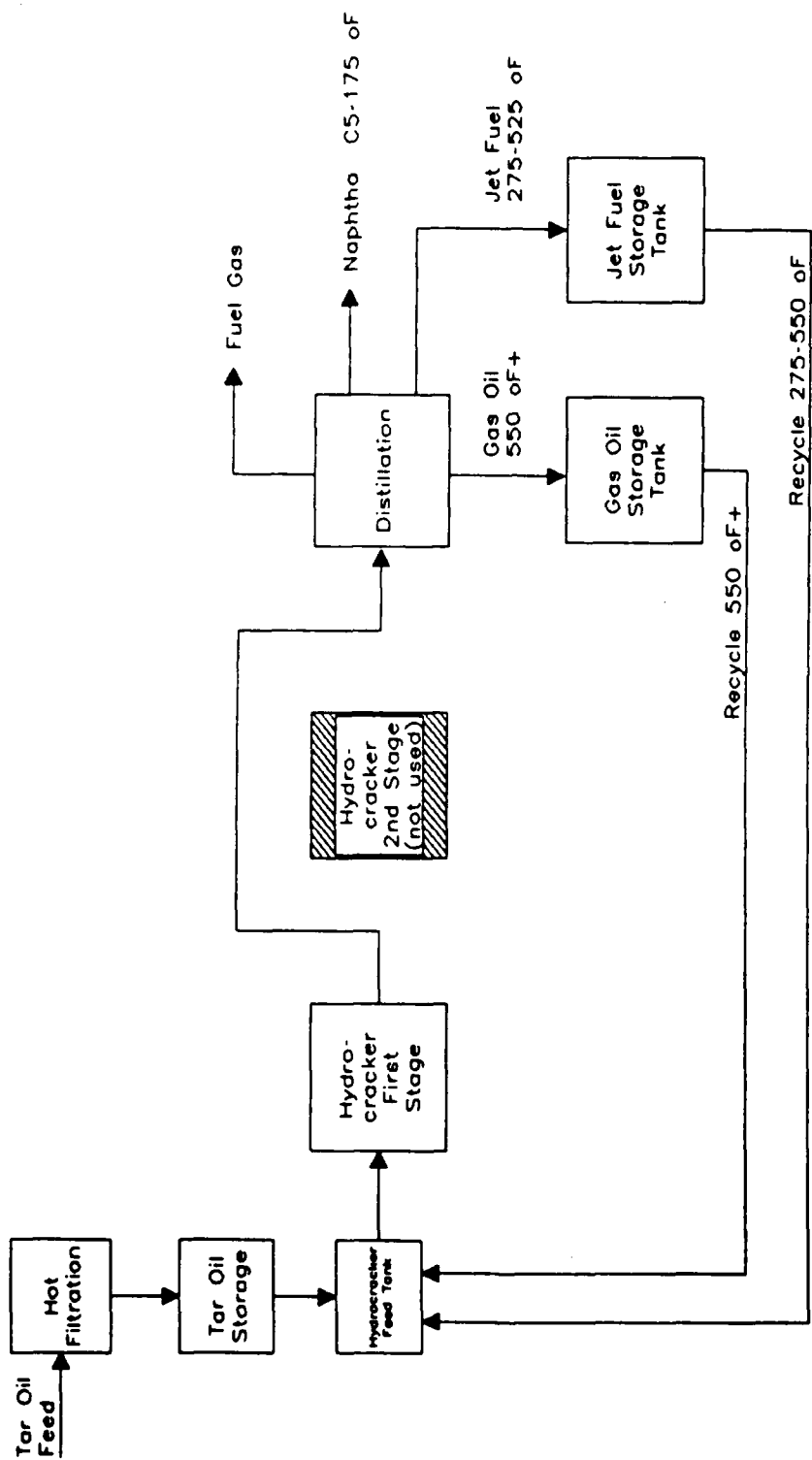


Figure 2 Hydrotreating Step
DOE Study Task 5
Lummus Crest March 1989

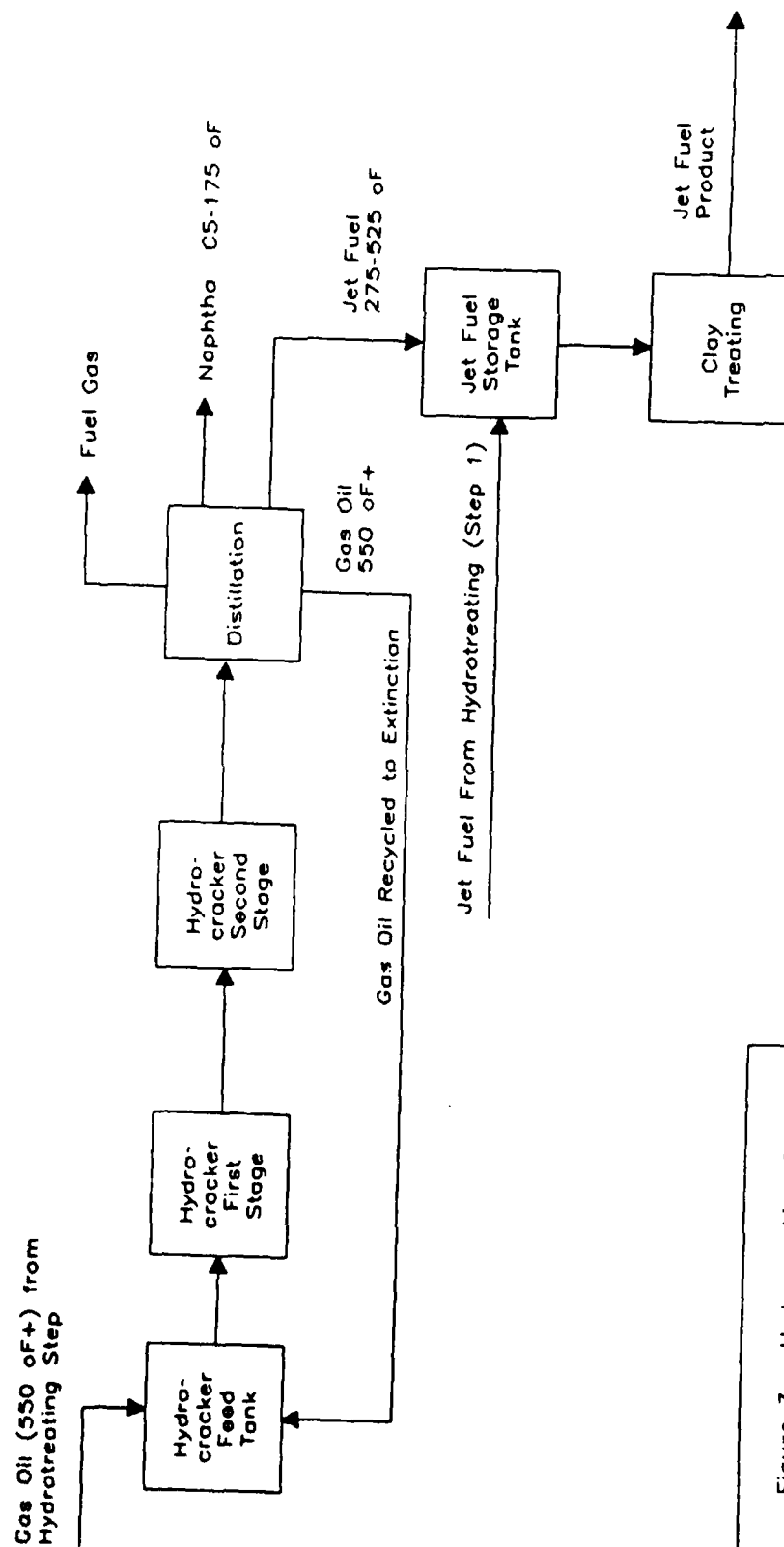


Figure 3 Hydrocracking Step
DOE Study Task 5
Lummus Crest March 1989

Table 1 Estimated Material Balance For Proposed Refinery Test Run

Step 1 Not Filtration

Note: This step is not needed if the VGO Hydrocracker has a feed filter capable of handling 0.5% solids. It is run as a 15000 bbl Batch and stored as feed for step 2

Component	Wt%	Vol%	Grav	#/SD	Bbl	Wt% S	Wt% N	Wt% O	Wt% Solid
Feed 300/550 of	49.50	51.89	0.9807	2670.0	7784				0.00
Feed 550/1020 of	50.00	47.86	1.0840	2697.0	7179				0.00
Solids Loss	0.50	0.25	2.0000	27.0	38				100.00
Total Feed	100.00	100.00	1.0280	5393.9	15000	0.49	0.73	5.44	0.50

Step 2 High Pressure Hydrotreating

This step uses the first stage of a two stage VGO Hydrocracker. This stage must have a H₂/HDS Catalyst, and is run initially with a 6/1 recycle ratio. Total pressure is at least 2000 Psig and the temperature is adjusted to 750 of.

Component	Wt%	Vol%	Grav	#/SD	BPSD	Wt% S	Wt% N	Wt% O
Feed 300/550 of	8.03	7.41	0.9807	178.0	519	0.488	0.726	5.443
Feed 550/1020 of	8.22	6.87	1.0840	182.4	481	0.488	0.726	5.443
Recycle 275/525 of	41.26	44.49	0.8400	915.0	3114	0.000	0.000	0.000
Recycle 525/1020	42.49	41.23	0.9335	942.4	2886	0.001	0.001	0.020
Total Oil Feed	100.00	100.00	0.9057	2217.8	7000	0.080	0.118	0.893
Chemical H ₂ (100%)	0.90			20.0				
Total Feed	100.90	100.00	0.9057	2237.8	7000	0.08	0.12	0.89

Total Reactor Products

H ₂ S	0.08			1.9				
NH ₃	0.14			3.2				
H ₂ O	1.00			22.3				
C1/C4	1.00			22.2				
C5/275 of	2.50	3.14	0.7200	55.4	220			
275/525 of	48.33	52.11	0.8400	1071.9	3648	0.000	0.000	0.000
525/1020 of	47.84	46.42	0.9335	1060.9	3249	0.001	0.001	0.020
Reactor Products	100.90	101.67		2237.8	7117	0.000	0.000	0.002

Net Products

H ₂ S	0.52			1.9				
NH ₃	0.88			3.2				
H ₂ O	6.18			22.3				
C1/C4	6.15			22.2				
C5/275 of	15.38	22.01	0.7200	55.4	220	0.000	0.000	0.000
275/525 of	43.52	53.39	0.8400	156.9	534	0.000	0.000	0.000
525/1020 of	32.89	36.31	0.9335	118.6	363	0.001	0.001	0.020
Net Products	105.54	111.71		380.4	1117	0.001	0.001	0.001

Table 1 Continued
=====

Step 3 High Pressure Hydrocracking

=====

This step uses both stages of a two stage VGO Hydrocracker.
The Hydrocracker converts 70 % of feed per pass. Total pressure is
at least 2000 Psig and the temperature is adjusted to 700 of.

Component	Wt%	Vol%	Grav	MB/SD	BPSD	Wt% S	Wt% N	Wt% O
Feed 550/1020 of	70.00	68.00	0.9335	118.6	363	0.001	0.001	0.020
Recycle 525/1020	30.00	32.00	0.8500	50.8	171	0.000	0.000	0.000
Total Oil Feed	100.00	100.00	0.9068	169.4	534	0.001	0.001	0.014
Chemical N2(100%)	1.88			3.2				
Total Feed	101.88			172.5				

Total Reactor Products								
H2S	0.00			0.0				
NH3	0.00			0.0				
H2O	0.01			0.0				
C1/C4	7.00			11.9				
C5/275 of	17.50	20.77	0.7200	29.6	118	0.000	0.000	0.000
275/525 of	47.37	49.07	0.8250	80.2	278	0.000	0.000	0.000
525/1020 of	30.00	30.16	0.8500	50.8	171	0.000	0.000	0.000
Reactor Products	101.88	100.00	0.8107	172.5	567	0.000	0.000	0.000

Total Products from Both Hydrotreating Steps

=====

Component	Wt%	Vol%	Grav	MB/SD	BPSD	Wt% S	Wt% N	Wt% O
C5/275 of	26.41	29.38	0.7200	85.1	338	0.000	0.000	0.000
275/525 of	73.59	70.62	0.8349	237.1	812	0.000	0.000	0.000
Total	100.00	100.00		322.2	1150	0.000	0.000	0.000

TABLE II

LIST OF REFINERIES WITH HYDROCRACKING CAPACITY

<u>Refinery Name & Address</u>	<u>Contact & Phone</u>	<u>Capacity BPSD</u>	<u>Feed</u>
Tesoro Petroleum Kenai Refinery Box 3691 Kenai, AK 99611	Jose Verdin 907-776-8191	9,000	Residue
Atlantic Richfield Watson Refinery Box 6210 Carson, CA 91749	A. W. Johnson 213-548-8000	22,000	Dist.
Chevron U.S.A. Richmond Refinery Box 1272 Richmond, CA 94802	J. P. Krider 415-620-3000	30,000	Residue
Mobil Oil Torrance Refinery 3700 West 190th St. Torrance, CA 90509-2929	L. K. Williams 213-328-2550	21,700	Dist.
Mobil Oil Beaumont Refinery Box 3311 Beaumont, TX 77704	J. A. Jones 409-883-9411	32,000	Dist.
Texaco Port Arthur Refinery Box 712 Port Arthur, TX 77640	R. E. Anderson 713-982-5711	15,000	Dist.
Texaco Bakersfield Refinery Box 1476 Bakersfield, CA 93302	D. R. Hall 805-326-4200	14,300	Dist.
Texaco Los Angeles Refinery Box 817 Wilmington, CA 90748	R. E. Morris 213-835-8261	20,000	Dist.
Tosco Avon Refinery Martinez, CA 94553	J. M. Cleary 415-228-1220	23,000	Dist.

<u>Refinery Name & Address</u>	<u>Contact & Phone</u>	<u>Capacity BPSD</u>	<u>Feed</u>
Unocal 1660 West Anaheim St. Box 758 Wilmington, CA 90744	A. V. Mandlekar 213-513-7600	22,000	Residue
Texaco Delaware City Refinery Delaware City, DE 19706	R. C. Mifflin 302-834-6000	19,000	
Hawaiian Independent 733 Bishop St. Suite 3000, Box 3379 Honolulu, HI 96813	Everett Lewis 808-547-3222	16,000	Residue
Clark Oil, Blue Island Division of APEX Oil 8182 Maryland Ave. St. Louis, MO 63105	S. A. Goldstein 314-889-9600	9,500	Dist.
Marathon Robinson Refinery Robinson, IL 62454	K. N. Warren 618-544-2121	23,000	Dist.
Kerr-McGee Wynnewood Refinery Box 305 Wynnewood, OK 73098	John L. Ray 405-665-4311	5,000	Dist.
Total Arkansas City Refinery 1400 South M St. Arkansas City, KS 76005	Jack Hazen 316-442-5100	3,200	Dist.
Exxon Baton Rouge Refinery Box 551 Baton Rouge, LA 70821-0551	D. H. Daigle 504-359-7711	24,000	Dist.
Exxon Billings Refinery Box 1163 Billings, MT 59103-1163	J. A. MacFarlane 406-657-5380	4,900	Dist.
Exxon Benica Refinery 3400 East 2nd St. Benica, CA 94510-1097	D. L. Wiggins 707-745-7011	29,500	Dist.

<u>Refinery Name & Address</u>	<u>Contact & Phone</u>	<u>Capacity BPSD</u>	<u>Feed</u>
Sohio 1150 South Metcalf St. Lima, OH 45804	P. Oves 419-226-2300	23,000	Dist.
Sohio Toledo Refinery Box 696 Toledo, OH 43964	J. T. Jacobson 419-698-6408	35,000	Dist.
Sohio Marcus Hook Refinery Box 428 Marcus Hook, PA 19061	J. M. Gibson 215-499-7000	21,000	